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The Impacts of Industry Development on Expropriated Households Welfare and Environment in Sabata town of Ethiopia

A Dissertation submitted to College of Development Studies, Center for Environment and Development, Addis Ababa University, in partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Development Studies (Environment and Development)

By

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We the undersigned prove that dissertation composed by **Fekede Terefe Gemeda**, entitled**"The Impacts of Industry development on Expropriated Households Welfare and Environment in Sabata town of Ethiopia"**is submitted in partialfulfillment of the requirements for the degree of doctor of philosophy in **Development Studies (Environment and Development)** capitulate in completion of the prerequisites for the Degree of Doctor of Philosophy comply with the regulation of university and convenes the accepted standards concerning the originality, quality, and eminence.

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Statement of Authorship

This dissertation is a thesis by publication in which Paper I, II, III, and IV are prepared as original research for publication. The Ph.D. candidate, Fekede Terefe Gemeda, was the corresponding author of these papers. The supervising team contributed to the papers by discussing the structure and editing as coauthors. The list of papers below showed the details of each of the manuscript have been submitted and the current articles track status and publications. As the manuscripts are separate and are submitted to different journal publishers, the formatting of the articles or manuscripts as per the respective journal and publishers requirements.

LIST OF PAPERS

Fekede Terefe (2021).Acquisition for Industrialization and Compensation Practices of Expropriation, Prepared manuscript, 44 pages.

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Dedication

This thesis is dedicated to my wife Ayantu Beyene Dibaba and my daughters Bilise Fekede Terefe, Kena Fekede Terefe, and Koti Fekede Terefe who have always stood by me and dealt with all of my absence from many family occasions with a smile. It is also dedicated to my mum Ebise Geleta Lemu who emphasized the importance of education and helped me with my lessons throughout my life.

Fekede Terefe Gemeda

Signature……………….

June, 2021

Abstract

This study examined the impacts of industrial development on the expropriated households' welfare and surrounding environment in Sabata town, Central Ethiopia. Household survey, focus group discussion, and key informant interviews were used to generate socio-economic data. The samples of industrial wastewater, soil, and vegetables were also collected to measure the concentration of physicochemical parameters and heavy metals in the samples. One-way ANOVA, endogenous switching regression, P-value, principal component analysis, Pearson correlation coefficient, hazard index, and bioacculmation factor were employed to analyze the the acquisition, compensation and expropriation practices; impact of industrialization on welfare of expropriated households; physicochemicalconcentration of river water and industrial wastewater;heavy metal concentration in wastewater, soil, and plants irrigated from industrial wastewater in the sampled area. The comparsion made between expropriated and non expropriated households based on income and expenditure. The results depicted that expropriated households' income decreases and personal expenditure increases contrary to non-expropriated households'. The electrical conductivity, biological oxygen demand, total suspended solid, total Nitrogen, and total Phosphorus were significant along spatio-temporality variation which depicts the disruption of river water quality by industrial industrial wastewater. The bio-concentration factor of heavy metals was higher than one for copper signifying the increasing probability of health risk for those who consume vegetables grown in the area. The soil and river systems in the industrial areas must be reclaimed/restored using the existing industrial pollution control standard, installation of the treatment plant, transformation of industrial residual into biogas products, and realization of corporate social responsibility. The land acquisition induced compensation practices and expropriated households' welfare must also need to be restored through the implementation of collaborative property valuation, resettlement programs, and allocation of share from the company.

Keywords: ***Acquisition; Compensation; Expropriation; Heavy metal; Physiochemical, Welfare***

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List of Abbreviations

ABCD	Asset Based Community Development
ADLI	Agricultural Development Led Industrialization
AfDB	Africa Development Bank
AGOA	Africa Growth and Opportunities Act
APHA	American Public Health Association
BoFEDO	Bureau of Finance & Economic Development of Oromia
COSD	Commission on Sustainable Development
CSA	Central Statistical Agency
DID	Development Induced Displacement
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EPCC	Ethiopian Panel on Climate Change
EPA	Environmental Protection Authority
EU	European Union
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
GIDP	Green Industrial Development Policy
IDS	Industry Development Strategy
IDSP	Industrial Development Strategic Plan
IRR	Impoverishment Risks and Reconstruction
ISIC	International Standard Industrial Classification

ISID	Inclusive and Sustainable Industrial Development
ISO	International Standard Organization
LIDI	Leather Industry Development Institute
MoI	Ministry of Industry
MVA	Manufacturing Value Added
OECD	Organization for Economic Cooperation and Development
ONRS	Oromia National Regional State
OPEDC	Oromia Planning and Economic Development Commission
OSZSF	Oromia Special Zone Surrounding Finfine
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
RRM	Risks and Reconstruction Model
SFW	Social Framework into projects
SLA	Sustainable Livelihood Approach
SSA	Sub-Saharan Africa
TIDI	Textile Industry Development Institute
UNDP	United Nations Development Programme
UK DfID	UK Department for International Development
UNIDO	United Nation Industrial Development Organization
WHO	World Health Organzation

Introduction

This thesis investigated the impacts of manufacturing industrial development on the welfare of expropriated households and the environment with emphasis on unemployment, social disarticulation, marginalization, landlessness, environmental pollution and food insecurity in Sabata town of Oromia Special Zone Surrounding Finfine, Ethiopia. Specifically, the study explores how expansion of manufacturing industries affected the welfare of expropriated households through land acquisition systems and methods of compensation payment by manufacturers or government for evicted households. The owners of the manufacturing industries in Sabata town have been thought to maneuver protection of environment perturbation. However, the land acquisition for industry induced compensation for the expropriated households were supposed to be not transparent, unfair, and not equitable to improve the welfare of the expropriated households. There have been no proper enforcement mechanisms in place to put the manufacturers under obligation to protect the environment.

Sabata town is known for its growing industrial pollution and the number of expropriated households as result of the boom of manufacturing industries for the last 3 decades. Empirical evidence showed that there are landlessness, loss of welfares, marginalization, social disarticulation, inadequate compensation that was misused, discharge of untreated industrial wastes in to water bodies and/or terrestrial land and upsurge in unemployment in the area rendering the households inveterate shortage and loss of acquiring sustainable welfare means (Cernea, 1997; Daniel, 2009; Teshome, 2014; Oromia Audit General, 2018).This could have led the expropriated households to desperate lives and caused environmental pollution. This thesis systematically explored the socio-cultural and environmental impacts of expansion of manufacturing industries on the welfares of expropriated households and the environment in Sabata town.

The impacts of land acquisition and compensation systems and environmental pollution on the welfares of the expropriated households were investigated. The results of the investigation can be considered by the policy makers to devise environmentally friendly and socially inclusive systems for industrial development.Attempts were made to analyze the socio-cultural impacts of the industrialization on the welfares of the expropriated households and environmental pollution from the local, national and development actors' perspectives. Conjugated Social Framework in to Project (Smyth and Vanclay, 2017) and environmental laboratory analysis were employed to analyze the benefit from the economic and environmental changes, whether fair and equitable compensation systems are deployed for the affected households and how the environmental protection was considered.

Ultimately mixed research approach comprising both quantitative and qualitative methods was employed including Key Informant Interview (KII), household survey questionnaires, Focus Group Discussion (FGD), and laboratory analysis of physicochemical parameters of industrial wastewater; heavy metal assay in soil, water, and irrigated vegetables affected by wastewater from manufacturing industries. The environmental data comparsion were done based on pollution threshold standards of the Industrial Pollution Standards of Ethiopia (2003), World Health Organization (WHO, 1994), World Food and Agriculture Organization(FAO), Indian Standard Institute (ISI), BIS, India Council of Ministries for Medical Research (ICMR), Canadian Council of Ministries for Environment (CCME), World Bank (WB), Environment Protection Agency (EPA) of U.S.A (USEPA), United Nations Industrial Development Organization (UNIDO), European Union (EU) and others.

Background

Industry development is vital for economic development, however, there is a need of optimual industrial waste management system, improve the wellbeing of expropriated communities, human and animals adverse effects.Industrialization is bedrock in arrears of various social transformation processes and modernization (UNU-WIDER, 2016). It can also lead to the rise of a new urbanization, change of lifestyle and pattern, technology diffusion, and socio-political thinking (Bekure, 2004). The effects of industrialization on socio-economic attributes portray the development of per capita manufacturing value and creation of employment opportunities (Urgaia, 2007).

According to Page (1994) the East Asian Miracle upshot of manufacturing industries was the result of the effort of transformation of the workers from lower to higher productivity sector. According to UNDP (2017) the value-added manufactured products were escalated two and half fold in 2015 than it was earlier. Manufacturing value added (MVA) per capita increased by nearly 59 percent in Less Developing Countries (LDCs) between 2005 and 2016, yet it was only about 2 percent of Europe and Northern America combined (UN, 2017).

However, the mounting local environmental risks and socioeconomic threats to the adjacent communities have been reported in many countries (Dodman et al., 2013). Specifically, most peri-urban dwellers have lost confidence in land rights security, tied together with confidentially for malpractices and thinking about impacts on the adjacent communities (Idris et al., 2017).

This study was conducted in Sabata Town of Oromia National Regional State, about 25 km southwest of Addis Ababa. Sabata town has 782 investment projects; of which 138 of them were manufacturing industries (OIC, 2018). The main rationale of an increase of manufacturing industries in Sabata town is due to its proximity to huge market for manufactured goods in Addis

Ababa city, transportation accessibility, comparative and competitive advantage of the area, strategic location, availability of different infrastructure and utility services (OIC, 2018)

Statement of the Problem

Ethiopia has recently recognized industrialization as an important sector for employment opportunity, poverty reduction and rapid development. Nonetheless, if the development strategy towards industrialization is not well managed it may bring significant impacts on the adjacent environment and society (Nebiyeleul, 2006; Mulu, 2013; Tesfay, 2014). The environmental disruption and associated social change may lead to social disarticulations, impoverishment of the expropriated groups/farmers, and can take-off public land use rights.

More often, when appropriate compensation is not offered to the expropriated households, it may delegitimize the efforts and challenges the importance of establishing the manufacturing industries or related development interventions. Expropriated households stumble across potential risks, associated with development activities such as losing their lands, jobs, homes, becoming marginalized, liable to diseases and death, poverty, denial of access to common properties, societal disarticulation and impoverishment (Cernea, 1997a). The increased demand for land acquisition/takings for development projects auxiliary boost to the miseries/perpetual poverty for expropriated persons/households and means of loss of welfare (Chakrabarti and Dhar.A, 2009). The chief problems of dislocation have been hardly fair compensation payment (Mohani, 2009).

Studies have also reported adverse environmental consequences of manufacturing industries. For example,the physiochemical parameters of the tannery and meat industries waste were found to be beyond pollution standard at downstream of both Modjo and Akaki rivers (Abrha et al., 2015); industrial waste of Tinishu Akaki River (TAR) filled adjoining soil with considerable hazardous chemicals that used for irrigated agriculture (Samuel, 2005);excessive quantity of heavy metals and chemical hazards pollutants that lead to socio-economic problems in the rural and industrial areas of the upstream of Addis Ababa city (Eticha, 2015) and communities surrounding manufacturing industries complain about health and environmental impacts of Bahir Dar textile factories (Assefa & Ayalew, 2014). However, many of these studies were not comprehensive enough to address the different systems (i.e, wastewater, soil and vegetable) and different industries use types of chemicals, input, process and impact on environment.

Other scholars contend that the unsustainable appropriations of agricultural land for industrialization and accompanied with municipal land use expansion over the past eight years in Gelan-Dukem Industry zone reported to have brought a significant and serious negative socioeconomic impact on smallholder farmers (Diriba, 2016). The study also revealed of the impacts of industrial pollution on the quality of surface water, the health of the residents and livestock and thus, suggested a policy option to re-examine the investment law and procedures, re-compensation payment to assist (ex-) farmers displaced or dispossessed for industrialization.

In summary, the research done in the past have focused on examining the impacts of the industrialization on some selected dispossessed and/or displaced farmers' welfare, but not comprehensively scrutinize the local community using social framework into projects and industrial pollution on the basis of industrial group with triplicate parameter laboratory analysis of soil, wastewater, and vegetable and comparative analysis of not expropriated and expropriated households welfare.

However, if policy change or government intervention needed, the previous studies did not package analysis of integrating socio-economic & environmental impacts of industry development on the acquisition, compensation, & expropriation practices (urban, peri-urban, and rural areas), comparative analysis of expropriated with non expropriated households welfare, trend of concentration of Physicochemical parameters of three years (2016-2018) from industrial wastewater, spatial-temporal variability and impacts of Physicochemical and heavy metal parameters concentration in river water, soil, & vegetables in 2019 from industry strata waste water (metal, textile, food, paper, tannery, alcohol and liquors, brewery, agro industry). These package indicators studies are vital, if the government need to change policy or intervention area to address the problems. Therefore, this study seeks to fill this research gap in the study area.

Objectives of the Study

This study aimed to investigate the impacts of expansion of industries on the environment (soil, river water, and vegetable) and expropriated households' welfare in Sabata town of the Oromia National Regional State, Ethiopia.

The specific objectives of the study were to:

1. Analyze land acquisition and compensation practices of industrialization driven expropriation in the study area (paper I).
2. Examine the impacts of industrial expansion on the welfare of expropriated households in the study area (paper II).
3. Characterize the physicochemical parameters of industrial wastewater in the study area (paper III).
4. Evaluate the level of heavy metals concentration in wastewater, soil, and vegetables grown on contaminated soil with industrial effluent wastes (paper IV)

Literature Review

Land expropriation and compensation methods

Expropriation is defined differently by different scholars including the concepts of its impact. According to Cernea (2003) expropriated households by development projects encountered potential risks such as landlessness, joblessness, homelessness, marginalization, increased morbidity and mortality, food insecurity, loss of access to common property, social disarticulation, and impoverishment. The increased demand for land acquisition for development projects leading to auxiliary boost to the miseries for expropriated households (Fernandes, 2000). The main problems of dislocation are lack of fair compensation payment (Mohani, 2009).

Cognizant to land acquisition, in Ethiopia land ownership is considered as State and public good in contrast to the situation in developed countries where land is considered as private property. In this regard, the Federal Democratic Republic of Ethiopia's (FDRE) constitution of 1995, article 40(8) stated land as a common property of the Nations, Nationalities and People of Ethiopia and shall not be subject to sale or other means of exchange. Since land is publicly owned, expropriation of land only involves taking away the land use rights for public interests and thereby a landholder entitled compensation payment for his/her property situated on the land and for permanent improvements made on the land (FDRE Proc.455/2005, 2005).

Regarding the compensation system, the expropriated households can get economic compensation mechanism but environmental compensation has to be resource-based compensated to the society rather than individual compensated in cash (Anders et al., 2015).The compensation payment for expropriation in Ethiopia is not equitable and just mainly due to difference in the standards of valuation and compensation among government institutions, inadequate compensation standards for loss of land use rights, lack of certified property valuation professionals, lack of reliable and up-to-date data, not transparent expropriation, and valuation procedures (Belachew, 2014). This also contradicts to some extent with the compensation systems in Nigeria where the expropriated households get adequate compensation, livelihood restoration and replacement for expropriated households by government so that the evicted households will not be exposed to psychological and emotional trauma (Olawuyi and Rahji, 2012).

Socioeconomic effects of expropriation

Welfare is viewed differently by different scholars as stringently correlated with sustainable growth and ecosystem services; as the societal indicators (Robert et al., 2003); index of life quality based on values (Diener, 1995); subjective wellbeing (Diener and Suh, 1996; Ryan and Deci,2000; Cummins and Nistico, 2002), and responsible wellbeing (Chambers,1997, Dluzewska, 2017). However, industrialists often give due concern to their own economic livelihoods rather than integrated benefits of the stackholders and wellbeing of the society.

There is also assumption that FDI explicitly has positive effect on recipient countries; however, there is an increasing evidence that, on a worldwide scale, an increased trade and investment flows from rich to poorer states have not led to a convergence of levels of income and well-being (Beck and Acc-Nikmehr, 2007). This is especially evident in the context of the former Soviet States from 1997 to 2005, many of which continue to have a fall in per capita GDP alongside a reduction in the life time expectancy of their populations because of the investments concentrated on a few, typical natural-resource-rich countries, and experienced massive fluctuations in terms of the amounts of FDI they received during those time periods (Beck and Acc-Nikmehr, 2007).

Environmental impacts of industries

The environmental effects of industrialization are dictated by the interests of the consumers of the products. For example the customers of Chinese similar to European and American firms, are demanding environmental and social compliance, whereas the African governments demand the social acceptability of the industrialization in recent time (Tang Xiaoyang & Irene Yuan Sun, 2016). On the other hand, India uses Pollution Index (PI) for characterization of industrial sectors under red, orange, green and white categories based on the industrial pollution status. Thus, industries having PI value of 60 and above taken as the increasing pollution load that is used to characterize industry pollution as red and PI values of 41 to 59 as orange (Ricardo et al., 2016). Industries with red category will not be accepted since they result in ecological fragility and need firm owners to establish cleaner technologies, and cutting down the level of emissions (Ricardo et al., 2016).

Industrialization has more pronounced and created impacts in the developing countries due to high population growth, low living standards, and presence of more pressure on environmental resources (Oketola and Osibanjo, 2009). The expansion of industrial sector affects the pollution load by an industry or a group of industries in a given area (Oketola and Osibanjo 2009) and thereby developing countries are increasingly concerned about growing pollution levels in cities (Oketola and Osibanjo, 2009). However, most developing countries have little or no data on industrial pollution (ibid). Generally, development and industrialization have both positive and detrimental impacts on the environment.

The Environment Protection Agency (EPA) of Ethiopia (2005) indicated a considerable quantity of industrial wastes emitted to surrounding water bodies, especially in the Addis Ababa city For example, the industrial waste from Akaki Kality industrial zone release in properly managing industrial waste and discharge to the proximate environment without any precaution and, thus, affecting the human health, however, the environmental regulatory bodies have not been getting hold of any measures to solve the trouble due to internal and external problems (Tesfay, 2014). It was revealed that the dust emitted from the manufacturing industries is affecting the physicochemical properties of the soils in the surrounding area (Samuel and Aynalem, 2012; Assefa, 2014a). The other study found out that, except temperature and pH, other physio-chemical parameters become beyond the pollution standard at downstream of Modjo and Akaki rivers (Abrha et al., 2015). Though the case is this, a variety of vegetables have been produced within and close to the urban centers, mainly using this polluted water for irrigation by smallholders (Hunegnaw, 2015). Due to this fact, most of the communities surrounding the manufacturing industries have been complaining about the health and environmental impacts of the industrial wastes discharged without treatment to terrestrial and into rivers (Assefa et al., 2014b).

Industrial waste water flow and industrial pollution loads of BOD in Kaliti, Akaki and Eastern Akaki river reached maximum permissible limit of BOD (Agaje, 2007). The study of polluting elements in a Tinishu Akaki River (TAR) showed that considerable accumulation of hazardous chemicals in the soil that is currently used for irrigated agriculture (Samuel, 2005). Therefore, the hazardous industrial chemicals that affected the soil in the TAR that was used for irrigated agriculture and thus, affect the human health that consumed crops or vegetables produced from such activity.

Inclusive and Sustainable Industrial Development (ISID)

The Weber Theory of location states that industrial location is affected by cost of transportation, labour and agglomerating or dis-agglomerating forces, that can be either material oriented or market-oriented (Richardson, 1969). Other scholar has viewed manufacturing industries at inception stage of production are material oriented and later stages as market oriented while intermediate stage relatively 'Footloose' as to transfer consideration (Hoover, 1963). Another theory of the Schumpeter’s Innovation Theory stated that the role of innovations and large-scale firms and thus the leading industry has strong backward and forward linkages that form clusters (Boudeville, 1966). However, Moran (1998) malign or benign model shows that the impact of International Foreign Direct Investment (iFDI) of manufacturing industries can be either destabilizing/negative and a stabilizing/positive impact on institutional competencies of host countries, respectively (Nikmehr, 2016).

In sum, Inclusive and Sustainable Industrial Development (ISID) was instigated in the Lima Declaration (2013) with the purposes of sustained industrialization as a motorist for development; socially inclusive development of equal opportunities and equitable distribution of benefits for all. Therefore, Inclusive and Sustainable Industrial Development (ISID) was used to analyze the land acquisition for industry development, expropriated households welfare and environmental protects.

Social Framework into project (SFW)

The manufacturing industries development has to take in to consideration in acquiring the sustainable community livelihoods for sustainable industry development and security. In connection to this, Michael Cernea (1990) developed Impoverishment Risk and Reconstruction (IRR) model for socio-economic solution to reconstruct the displaced community (Cernea, 1997). Other philosophers Jeremy Bentham (1748-1832) and John Stuart Mill (1806-1873) founder of Utilitarianism as Consequentialism (teleological) theory stipulate that actions are right, if they bring happiness or altruism (benefit to everyone) or greatest utility or intrinsic value (value in itself) and minimize pain and unhappiness to benefit of the society or best for most households (Kairalla, 2006).

In nutshell, Smyth and Vanclay (2017) initiated Social Framework into projects (SFW) by analyzing and evaluating pre-existing models such as Sustainable Livelihoods Approach **(**SLA) of UK Department for International Development (UK DfID, 1990); Impoverishment Risks and Reconstruction (IRR) model of Michael Cernea (1997); Entitlement Theory and Capability Approach (ETCA) of Amartya Sen; Asset Based Community Development (ABCD) and Capital-Based Approach (CBA). Thus, the Social Framework into projects (SFW) presents strategic social and environmental types that projects or industries impact on household's welfare (Smyth and Vanclay, 2017). The SFW consists of eight attributes for households' welfare such as land, household, community, culture, infrastructure, livelihoods, housing and environment. Therefore, this study employed the Social Frame Work into project to analyze the impacts of industries on expropriated households welfare and environment.

Analytical framework

An in-depth review of literatures was done to acquire knowledge concerning the framework for research work. Inclusive and Sustainable Industrial Development (ISID) states that industries have to be socially inclusive provide equal opportunities, and equitable distribution of benefits for all. The SWF was also employed to analyse the households' welfare using land, household, culture, infrastructure, housing and environment. In so doing, the expansion of manufacturing industries in Sabata town and its environs was considered to have both positive and detrimental effects on expropriated households welfare and environment. The detrimental effects are severe and multidimensional resulting in a number of effects on the welfares of communities and the environment as stated above. Albeit to this, the boom of industrialization in the area proliferate land transformation into development of different types of manufacturing industries. The framework of study considers land expropriation, weak contribution of manufacturers for improving community's welfares and uncomfortable living environment for community as the main contests of manufacturing industries in the area (Figure 1.2).

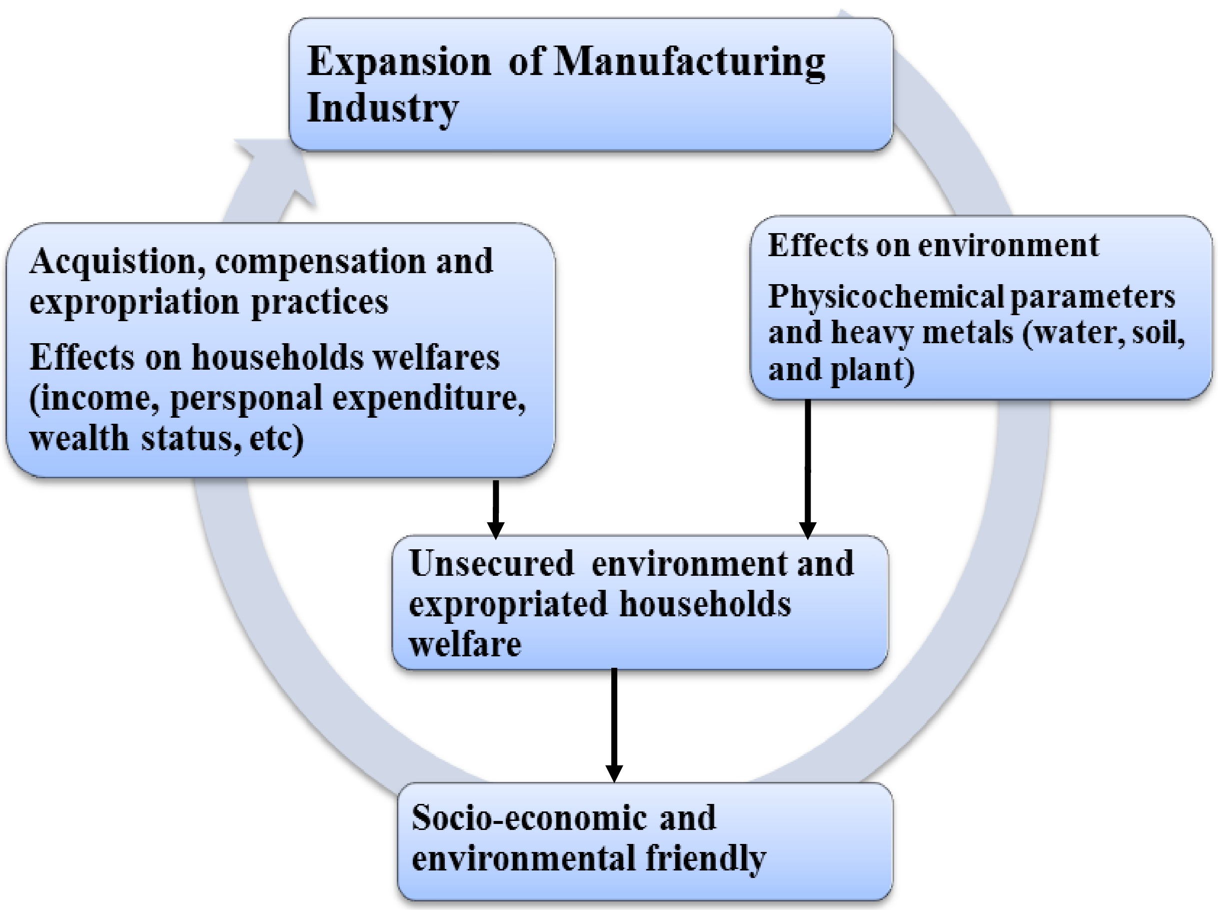

Figure 1.1 Analytical framework

Materials and methods

Description of the study area

The study was conducted in and around Sabata town. The Sabata town is situated at about 25 km the Southwest of Addis Ababa. It is situated at $8^0$53'39" N to $8^0$59'58'' N latitude and $38^0$35'12'' E to $38^0$39'34'' E longitude (Figure 1.1). The altitude of the town ranges from 2,060 to 2,670 meters above sea level. Sabata town was selected for this study owing to the manufacturing industries expansion with high agglomeration of factories with partial or no treatement for industrial wastewater in the area.

Population and Economic activities

The estimated total population of Sabata town was 80,437 in 2015 (Dejene, 2011).The number of population was increasing alarmingly to 360,000 in 2019 (Sabata Town Municipality Office, 2020).The urban expansion accompanied by industrialization has resulted in economic dynamics.The communities reside along these rivers and use the Sabata, Harbu Dano, and Atebella river for farming, drinking and other purposes was affected by the industrial wastewater that cause of the problem on community, animals,vegetables, water, and soil that discharged from industries in the area. The interviewee also revealed that communities that used Atabala and Sabata Rivers have lost the benefits of getting drinking for animals and people, bathing, swimming, and irrigations due to industry wastes polluted the rivers in the area.

This research work focused on 138 operational manufacturing industries, However, no industries under pre-implementation, under construction, construction completed, not implemented and abandoned factories of Sabata town were not considered in the study. This is because operational manufacturing industries indicate further explicitly the positive and/or negative impacts on the socio-economic and environmental issues in the area. The purpose of this research is to find out impacts of industries on expropriated households welfare and environment from pollution perspectives.

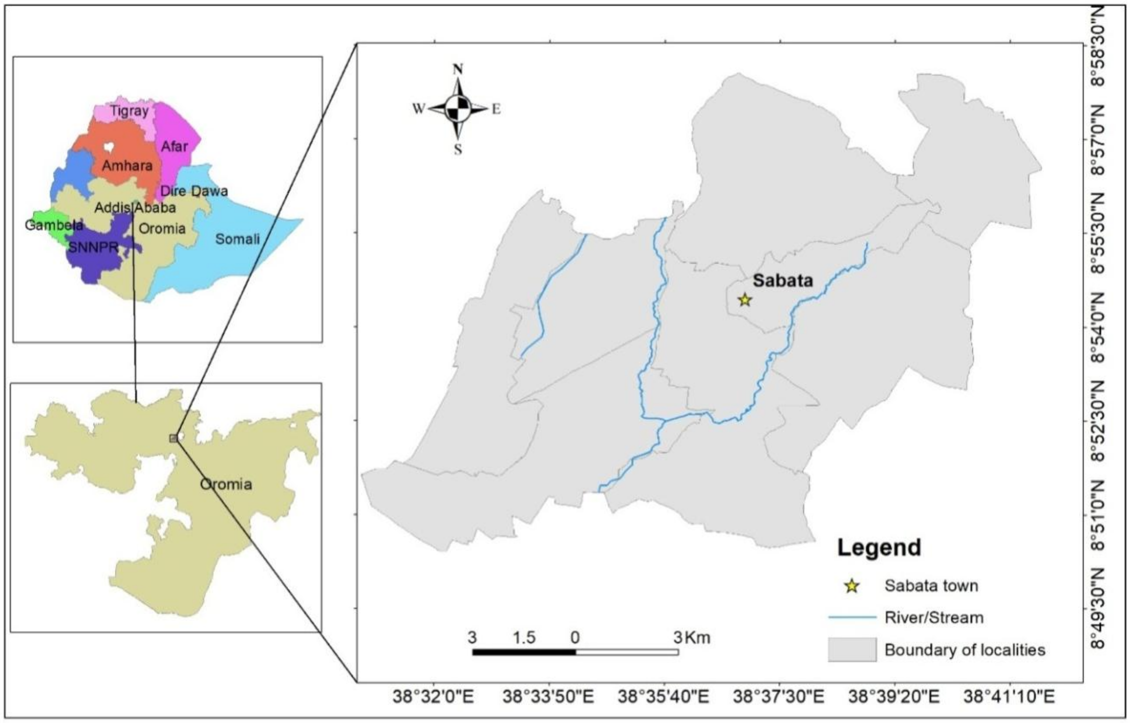

Figure 1.2 Map of population and economic activities of the study area

Research Design

In this study a mixed research approaches was employed. A mixed research approaches was designed to address concurrent triangulation strategies with concurrent data collection process and data analysis (Terrell, 2012; Creswell , 2014). This study also used pragmatism paradigm and thus, combined the quantitative and qualitative approaches at different phases of research process (Terrell, 2012). The quantitative approach is a deductive approach (Almalki, 2016), mathematically based methods (Muijs, 2004), describes "if", a positivists paradigm as a cornerstone for social science research and remain emotionally detached (Johnson, 2004), surveys gathering numerical data and generalizing it across groups of households (Blaikie, 2000). Whereas the qualitative research is an inductive method and difficult to measure, complex and interwoven as well as data collected shows an insider's viewpoint (Almalki, 2016), describes how or why of the interpretative paradigm of the value bound and subjective knower for source of reality (Johnson, 2004), individual or communal problems (Creswell, 2014) ,and subjectivity about values, culture, and social justice (Tracy, 2013).

This study employed both qualitative and quantitative data, since it allows a wide-ranging and all-inclusive thoughtful of the impact of manufacturing industries on expropriated household welfare and environment.

The quantitative attributes of expropriated household welfare, land acquisition and compensation system, and environment indicator were collected and analyzed using the parameters such as land, household, community, asset, living environment, income, compensation valuation methods, physicochemical parameters, heavy metal parameters, and infrastructures. These data were generated through methods such as households' surveys, participant observations and secondary documents. Whereas, qualitative attributes of the knowledge, culture, vulnerability to industrial waste hazards, human and animals health issues, land acquisition and compensation payment system were also collected and analyzed. Different participatory approach was used like interviews, case studies, court cases, personal observation and examination of archives as system for acquiring qualitative data.

Regarding data sources, this study employed primary and secondary data sources. The primary data was obtained from survey questionnaires, interview, personal observation, and environmental laboratory results. Whereas the secondary data were gathered from literature and other agents such as government and non-governmental organizations' reports and records related to manufacturing industries in the study area. The data sources include policy documents, books, proceedings, proclamation documents, journals, magazines, newspapers, statistical bulletin, articles, internet, thesis, dissertation, internal reports, urban, and rural land administration reports.

Sampling techniques and sample size determination

The study employed stratified sampling techniques. Initially the industry group, expropriated and not expropriated households were purposely selected because they are pertinent and vivacious for the study. Prior to data collection the lists of industries, expropriated and not expropriated households were obtained. Accordingly, the eight industries were purposely selected as they have impact on expropriated households' welfare in the area.

Samples of river-water, soil, and vegetables were collected for laboratory test to assay for heavy metals (i.e. a group of elements that can be toxic when consumed by humans) contents of the chemical elements in Kg/ppm (parts per million) in the water, soil, and vegetable tissues of using AA+20 Atomic Absorption spectrophotometer. The sampling was based on APHA (1999).

GPS reading were taken for all sampling sites such as wastewater, river water, vegetables, and soil sites during field survey to depict relevant events as well as capturing important information that complements other data collection methods. The expected pollution of industries was identified and recorded using the laboratory analysis method. The samples from wastewater were taken for analysis of physiochemical parameters such as pH, temperature, Electrical Conductivity (EC), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Ammonia, Total Nitrogen (TN), Total Phosphorus (TP), and heavy metals such as Lead (Pb), Nickel (Ni), Copper (Co), Manganese (Mn), and Zinc (Zn). The composite wastewater, soil, and vegetable samples were taken to test heavy metal characteristics of the sampling attributes using standard methods.

Household sampling

The sample size was estimated using a formula given by Cochran (1977) for multistage stratified sampling method using attributes of expropriated households, non-expropriated households, and stakeholder of business institutions. The acceptable marginal error and the alpha level considered by this study were estimated as described by (McLean and Ernest, 1998). Additionally, the contingency rate of 20 % was used to accommodate the missing data as a result of noncompliance by the respondents. Prior to sample size determination, it was crucial to identify attributes such as the number of expropriated households and not expropriated households of the study area.

For this study participants constitute a sampling unit. Cognizant to this, multistage sampling techniques were employed to select manufacturing industry group in order to include all types of manufacturing industries. That is, the various manufacturing industries found in the area serve as the target industries to which generalization is to be made. Therefore, the researcher deployed scientific multistage sampling method to minimize the sampling bias as much as possible. This research was based on multistage sampling method using attributes of expropriated households, public sector, and other stakeholder in the area. Albeit to this, Cochran (1977) suggested that the marginal error to be vital to consider for the study (McLean and Ernest, 1998). So, the acceptable marginal error for categorical and continuous data of the study were 5 % and 3 % respectively (Cocharn, 1977). Nevertheless, this study utilized the 5 % marginal error as the most prominent and commonly practiced in social science research.

For sample size determination, it was crucial to identify attributes such as the number of expropriated households of the study area. The total number of expropriated households was about 3,665 (of which 1000 expropriated households by operational manufacturing industries) during the years 1992 to 2017/18 (Central Oromia Displaced Community Development Affair Agency, 2018). Based on this baseline data, this study was used a Kothari (2004) formula to determine sample size. The sample size of expropriated households was

$$n = \frac{N.\ z.\ p.\ q}{e^2(N-1) + z^2.p.q}$$

Where n=sample size

z=95% confidence interval under normal curve (1.96)

e=margin of error (0.05)

p=proportion of sampled population (0.5)

q=estimates of the proportion of sample population

N=total expropriated population by operational industries (1000)

p. q=0.25

It has been clear from literature that appropriate sample size can vary for different qualitative studies and different recommendation avail by different scholars. Hence, about thirty to fifty participants for an ethnography (Morse, 1994); thirty to fifty interviews for grounded theory (Morse, 1994); about twenty to thirty for phenomenological studies (Creswell, 1998) were recommended.However, as few as five to twenty five interviews (Creswell, 1998) and at least six interviews(Morse,1994) have also been suggested (Accessed online.http://www.Statistics solutions.com/qualitative-sample-size/, October 22/2018/19).

The expropriated households of the town were about 3,665 from 1992 to 2017 (Central Oromia Displaced Community Affair Office, 2018), about 1200 not expropriated households on suburban areas of Sabata town (Sabbata Town Administration office, 2017/18) and there were 138 operational manufacturing industries in the town (OIC, 2017). Using the above base data, this research used a (Kothari, 2004) formula to determine sample size for the study.

Thus, 240 expropriated respondents and 288 not expropriated households affected by the industries were selected. Finally, this study collected survey data from total of 449 households, of which 205 were expropriated and 244 non-expropriated households. The response rate was 84.4 %. The rest 14.6 % was incomplete response and rejected responses.

Furthermore, the samples needed for the qualitative approach was estimated as recommended by different scholars such as Glaser and Strauss (1967) considering saturation level; Morse (1994) suggested 30 to 50 individuals; Morse (1994) 30 to 50 individuals while Creswell (1998) 20 to 30 individuals, Creswell (1998) recommends 5 to 25 (http://www.Statisticssol utions.com/ qualitative-sample-size/). In this study the sample size for FGD in the qualitative survey was estimated to be fifteen and lie under fifty with six to eight participants and at least two FGD per population group (Amugune, 2014). Moreover, this study deployed five participants for one FGD with separated and mixed group of male and female expropriated and non-expropriated households. Also, this study was used the preferred sample size for qualitative analysis of the saturation level (Glaser and Strauss, 1967).Thus, this study was deployed data collection five participants selected of 10 and 19 FGD and KII making a total of 29 groups (145 individuals) for qualitative analysis.

Environmental sampling

Wastewater of industrial group was taken using a water sampler. Following this, the wastewater sample was designated as W1 to W8 along the water course or sewerage areas. Therefore, the industrial pollution samples were studied from the treatment group wastewater sample (8*4=32) and control group of one composite sample from Wacaca Mountain or drinking water, which was a total of 32 sample sites.

Furthermore, contaminated wastewater was commonly used for irrigated vegetable farms in Sabata town at downstream for decades, that deliver an impact on safety of vegetables farm, and hence, this study was intended to measure the levels of heavy metals such as Copper, Lead, Zinc, Manganese, and Nickel in the surrounding vegetable farms. So, the irrigated vegetables of the composite samples, and four subsample sites for four vegetable types (lettuce, cabbage, garden cabbage, and red beet) in contaminated irrigated area (4*8*2=64) in dry and wet season were included. The composite sample of the treatment and control group was 8.

On the other hand, the soil samples were taken from farming area, forest/buffer zone and grazing sites, which have a contact with contaminated industrial wastes. The quadruplicate of subsamples into 8 composite soil samples were taken from forest area/buffer zone, irrigated land, rain fed farming and wetland (8*4*2=64) of treatment group and one sample of control group from rain fed farming or mountain area, making a total of 64 subsamples. In essence, the composite soil samples were 64 subsamples of different soils.

To boot, the samples of heavy metal parameters from industrial wastes was collected from total of 64, 32 and 64 from soil, wastewater, and vegetables samples from composite samples of 8, 6 and 8 during wet and dry seasons.

Data collection instruments

Socioeconomic data

This study used different methods or instruments for data collection, such as checklists, KII, FGD, and households survey questionnaires for secondary data collection. Mainly cross-sectional approach was used to gather the necessary data. In addition, FGD, KII, and personal observation were employed for primary data collection.

Multistage sampling was used to collect data from town and community. First, eight local administrative units in Sabata town were selected purposively based on the information regarding recent land expropriation cases. The households from which was lands taken interviewed from eight local administrative units. It was noted that land-expropriated households of peri-urban area, that were asked questions came from various localities. Taken together 205 expropriated households were selected from the eight local administration units.

In this survey data, the questionnaire was designed to fetch information regarding the consent of households from which was taken for the sake of industrial development, its influence on the change of employment, and residence after expropriation.The households were given chance to rank their consent to expropriate households to change job. Hence, the overall degree of agree of expropriated households to change welfare of the households was enumerated on a five-scale likert approach ranging from one (not agree) to five (agree).

Quantitative data were collected from 205 randomly selected expropriated households. A pre-tested structured questionnaire was employed to collect quantitative data. The questionnaires contained different parts that include demographic and socio-economic characteristics of the respondents, the consent of the target group for land takings, participatory in property valuation, land acquisition process and perception of expropriated households in the area. The qualitative data were collected using Focus Group Discussion (FGD) and Key Informant Interviews (KII). A total of 19 key informant interviewees and 10 focus group discussions were employed for qualitative data collection.

Environmental data collection instruments

The composite soil samples were taken and acid digested and then their concentration content investigation using UV-VIS Spectrophotometer. The pH and electrical conductivity of the samples were defined applying the pawns of a potentiometer of the pH meter and portable conductivity meter (black, 1965) respectively. The analysis of heavy metals in the soil was done using the tools of UV-VIS Spectrophotometer (AAS) while, digestion of the vegetable samples for some of the heavy metals analysis was conducted using the tools of the DjelDahl Digestion Apparatus.While, the total concentration of industry wastewater of metals are obtained by acid digestion and read directly through UV-VIS Spectrophotometer.

The testing of the parameters was grounded along the maximum permissible level (MPL) or recommended maximum limit (RML) standard of WHO/FAO (1993) or EU or SEPC (China) or EPA (USA) and EPA (Ethiopia 2003) for the examination of wastewater, soil, and vegetable samples. Thus, physicochemical parameters were studied using standard methods (APHA, 1999); conductivity, and pH using portable devices or portable pH meter and conductivity meter (Black, 1965). The composite soil sample was tested using UV-VIS Spectrophotometery (AAS) sites.

Relevance of the study

Both academic institutions and policy makers can benefit from the results of this study. The results of assessment of impacts of manufacturing industries on the welfares of expropriated households and environment are crucial for further development activities, useful for academicians, policy makers and practitioners focusing on mitigation of development associated problems. This may guide policy process to the sustainable improvement of the welfare of expropriated households and sustainable environmental plan that facilitates the symbiotic, inclusive, equity, and collaborative symbiotic sustainable development. Since Ethiopia is making steps towards implementation of sustainable growth, African Agenda of Action Plan and Growth and Transformation Plan (GTP II), the findings of this study are expected to be of paramount significance for strategy towards enhancements of the role of sustainable welfare improvement of expropriated households and sustainable environment protection.

Method of data analysis

Socio-economic impact analysis

The quantitative data was analyzed using descriptive statistics for expropriated households consent to change job after industry land acquisition process. To complement quantitative data, the qualitative data was transcribed and analyzed to triangulate the quantitative data. The simple regression model was used to analyze the industry induced expropriated households to change job using the determinant factors such as education level, empowerment, participation, mutual consent, allocation of land for home construction, and other variables. The industry land acquisition and compensation led expropriated households to change job was analyzed using inferential statistics.

The quantitative data of the study of impact of industries on expropriated welfares were analyzed using Endogenous Switching Regression Model were applied. The descriptive statistics with help of SPSS version 21 and Stata version 14 were also employed to test the significance of variables and analysis of the expropriated households' welfare. The four cluster of livelihood zone of Oromia (Ministry of Agriculture and Tanga Boudreaus of FEG, 2018) was employed for expropriated and non-expropriated households' welfare analysis based on wealth group using descriptive statistics analysis.

At each stage of discussions, the secondary information obtained from different sources was added to make the survey analysis to be inclusive. On the other hand, qualitative data from KII and FGD was transcribed, categorized, enumerated, looked for relationships, and interpreted. The qualitative data via KII and FGD were also qualitatively analyzed and integrated to support the survey results for triangulation purposes as suggested by Guba and Lincoln (1985).

Statisical analysis of environmental data

The data was collected, analyzed and presented using appropriate methods of analysis. The quantitative data of the study was analyzed using various analytical methods such as descriptive statistics and a One-way ANOVA to examine the significance level of different heavy metals and physicochemical parameter concentration by industry type waste water, vegetable type, and soil sampled sites. To boot, the environmental laboratory test of wastewater, soil, and vegetable were analyzed using the R software version 3.4. The analyzed data was summarized and presented by using different kinds of illustrations, statistical tables, graphs, and charts.

Analysis of variance (ANOVA) was used to compare the concentration of heavy metals. The environmental data was analyzed using, relative standard deviation (% RSD) and principal component analysis, and Pearson's correlation coefficient. The concentration of physicochemical and heavy metal was compared against international standard of water, soil, and vegetable quality.

Concomitantly, the Arc GIS 10.3 software was likewise utilized to map the waste emitted to streams/rivers areas, laboratory sampled sites of soil, vegetables, and wastewater of the groups of manufacturing industries. The rendering of qualitative data was employed to descriptive narratives in order to complement the quantitative information.

The structure of thesis

The thesis is divided into six sections. The first part describes the background of the problem, the philosophical approach to the investigation and description of the study area. The paper one through paper four present the results of field investigation conducted in this study. The land acquisition led industrial development effects on expropriated household consent to change job are captured by analytical approach in paper one. The factors affecting expropriated households to change job are clean environment, rehabilitation, accessibility to infrastructure, and satisfaction with compensation paid that influence consent to change job after expropriation. This paper concludes that awareness of society, understanding pre objectives and clean environment are vital to make change job after expropriation (paper one).

The second paper conceptualizes impact of industries on expropriated household welfare from the ISSD and social framework into projects perspectives. This paper addresses comparative analysis of the expropriated and non expropriated household by analysis of their total income and personal expenditure. This study showed the total income decrease and personal expending increase for expropriated households contrasting to non expropriated households, implying the corrosion of the welfare of expropriated households in the study area.

The third paper presents results of characterization of physicochemical from industrial waste water in the area. This paper investigated about temperature, BOD, COD, Electrical conductivity, Total Phosphorus, Ammonia in the study area. The forth paper presents results of analysis of the concentration of heavy metals in soil, water, and vegetable samples in the area. The study results indicated the pollution of the environment due to untreated industrial wastewater discharged in to surrounding river, soil, and irrigated vegetable in the Sabata town and its environs.

Table 1. Structure of the thesis

Research Focus	Methods	Outputs	Outcomes
Land Acquisition , compensation, and expropriation for industry development	Survey, FGD, KII, , SPSS version 21 ,Stata version 14, Descriptive statistics, qualitative analysis	• Dissatisfaction with compensation payment • Settled in areas of inaccessible infrastructure • No standard for valuation of property • Lack of participation in valuation • Lack of resettlement and rehabilitation • Loss cultural intact • About 72.4 % of expropriated households incomes are below the poverty line • 3.4 % of the expropriated households do not have any income	• Professional property valuation • Initiation of property valuation institution • Preparation of standard for property valuation • Establishment of resettlement and rehabilitation strategy for evicted households welfare • implementation of collaborative property valuation • Protection of primordial identity of the society
Impact of industrialization on welfare of expropriated households	Households survey, KII, FGD, Social Framework in to projects, Economy Analysis framework, SPSS version 21 ,Stata version 14, ESRM, ANOVA Descriptive statistics,	• Low annual income of expropriated households • High personal expending for expropriated • Poor wealth status for expropriated households • Loss of landholding as base of welfare asset	• expropriated household livelihood improvement fund • Provision of income generation system • Implementation of sustainable corporate social responsibility • Provision of share for expropriated households from company
Characterize physicochemical indicator from industrial wastewater	Composite sampling, APHA, one way ANOVA, Arc GIS 10.3 to map of sample sites, R software version 3.4	• High amount of BOD, COD, and TSS in waste water • The concentration of EC, BOD, COD, and pH were above safe limit in middle stream and downstream of Sabata river • The water was in phytotoxic level of pollution	• Eco manufacturing industry development • sustainable environment management • Mitigation measures through implementation of treatment technology • Sustainable monitoring and evaluation of industrial waste management strategy
Occurrence of heavy metals in soil, water, and irrigated vegetable in industrial waste water	Composite sampling, APHA, R software version 3.4, Arc GIS 10.3 to map of sample sites, ANOVA, % RSD, PCA, Pearson correlation coefficient, BCF,DIM, THQ	• Pb>Mn>Ni>Cu>Zn in Sabata river • Mn>Ni>Pb>Cu>Zn in soil • Ni>Pb>Mn>Cu>Zn in vegetable • High BCF value of Cu in lettuce in both wet and dry seasons	• sustainable integrated industrial waste management system • Implementation treatment technology • Use of phytoremediation strategy

Results

This study revealed that manufacturing industries had negative impacts on the welfare of expropriated households and the environment. This study finding showed that land acquisition and compensation practices for industrial development driven households' expropriation had significant negative correlation with property valuation, satisfaction with compensation, and better infrastructure in the area. Undervalued compensation payment and corruption that culminate into inequitable benefit, distortion in measurement of land holdings for compensation, and not empowering landholders to negotiate with land user in the process of property valuation were some of the grievances expropriated households outlined. These have raised intriguing questions regarding land acquisition and compensation practices for sustainable improvement and recovery of expropriated households' way of life.

Complement to this, the discussants expressed the procedures of property valuation for land acquisition for industrial development was arbitrary that not offers sustainable income generation. This study also showed that 68.3 % of the respondents stated that their family/communal cultural settings were disappeared and causing disappointment among the households.

The impacts of manufacturing industries on the expropriated households' welfare showed that there were inability to develop asset (loss of landholdings, transformation from own farming to wage employment), unable to send children to school, low living standard, loss of means of income generation, and increase of personal consumption expenditure which led to upsurge in poverty and destitution.

Income earnings for the expropriated households also showed decreasing trends and categorized into poor wealth status compared to the non-expropriated households for whom the income showed increasing patterns and categorized into middle wealth status. Therefore, expansion of manufacturing industries has affected more expropriated household than non expropriated households. On the other hand, the predicted personal expenditures showed an increase for the expropriated while it showed decreasing trend for the non expropriated households. This could be due to increased expenses for purchase of food items, transportation services, utility services, medical costs, school fees, and other expenses.

On top of the socioeconomic impacts, the expansion of industries in Sabata town has also affected the environment as a result of disposal of untreated industries wastes into the physical environment.The temporal values of the physicochemical parameters of industrial industrial wastewater investigated in the area revealing high levels of BOD, COD, and TSS of above the WHO safe limit. The pH of the industrial wastewater from alcohol and liquor factories and tanneries surpassed the permissible limit. The physicochemical parameters such as temperature, BOD, COD, EC, TSS, TN, and TP analyzed from industrial wastewaters were statistically significantly different ($P=0.05$) with that of the water samples collected and analyzed from upper stream (control).

The results of spatial analysis showed that the values of EC, BOD, COD, and pH were greater than the threshold level of WHO in the middle and lower streams of Sabata River compared to the upper stream indicating water pollution of the middle and down streams. So, Sabata River is not safe for drinking, irrigation, and other purposes any more. These wastes from the industries were also often openly discharged untreated or only partially treated into the environment jeopardizing the health of the community and their livestock.

The tempo-spatial concentrations of heavy metals were above the permissible limit of WHO and USEPA in the middle and downstream of Sabata River during dry and wet seasons. The concentration of Pb was higher than the safe limit of USEPA in soil samples assayed from irrigated land, forest areas, and wetland. Similarly, the level of Pb was higher than the safe limit of WHO/FAO in red beet grown on irrigated farm during wet season. The cconcentration of heavy metals ordered as Pb>Mn>Ni>Cu>Zn in the Sabata river; Mn>Ni>Pb>Cu>Zn in soil, and Ni>Pb>Mn>Cu>Zn in vegetable samples, respectively. The concentration of heavy metal was varying in water, soil, and vegetable because of the heavy metal speciation and valence, industry types, the difference in biodegradability, vegetable types and tissues, and others. The high bioconcentration factor value was revealed in Cu of lettuce in both wet and dry seasons.

Synthesis

Industrialization is widely viewed as the primary sources of economic growth and climate change (Majeed and Tauqir, 2020).In many developing countries; land acquisition is associated with development paradigm and economic growth through industrialization.Simultaneously, regulating the impacts of industrialization on environment and expropriated households have been a hot discourse among the scholars and policy makers until today. For example, a major problem of contemporary development policy concern is as to how to compensate whose traditional livelihoods are uprooted by modern industrial expansion (Ghatak and Mookherjee, 2011). Similarly, Ethiopia being predominantly agriculture based economy, land is not only used for food production or a source of livelihood but also a symbol of social identity, status, and wealth. Loss of land due to industry expansion in Ethiopia thus came under scrutiny and the extent and impact of land acquisition were questioned stridently. So, in the absence of a well defined land acquisition and compensation policy, there will be practical concern of the sustainability of the development efforts.

Land acquisition, compensation, expropriation, and its impact on expropriated households' welfare

The land acquisition for industrial development in Sabata town is on the rise. The results of this study showed that it has brought negative effects on the expropriated households' job opportunities, curtailed their subsistence farming, and contributed to an upsurge in poverty. Our observation is in consent with previous reports, which reveal that the expropriated households are exposed to multitudes of problems such as insecurity of tenure, socio-cultural destruction, and unfair compensation for their landholding takings (Mulatu, 2018). This calls the policy makers to take into account the socio-economic impacts of industrialization.

About 90 % of the respondents revealed dissatisfaction with the compensation payment. Moreover, they were not rehabilitated and lost their welfare. Studies conducted by Sayeh and Mansberger (2020) in Bahir Dar and Debre Markos towns of Ethiopia reported findings that are in agreement with study, where the majority of the expropriated farmers did not get fair compensation payments. Our observation is also in consent with the land acquisition and compensation systems in China, which does not address the issue of compensation resulting in great discontenting (Chan, 2003). Similar results have been reported in China that demonstrated the negative impacts of land expropriation accessibility to natural, financial, and social capitals (Guo et al., 2019) and elsewhere in the world (Ghatak and Mookherjee, 2014). Similarly, unfair displacement laws and compensation has caused grievances in Kigali, Rwanda (Mugisha, 2015). All these suggest that there are widespread land acquisition systems, which do not take into account the welfare of the expropriated households. These show the needs to revise the existing rules and regulation regarding land acquisition and compensation for development projects expansion.

The majority of the respondents disclosed that they are not given resettlement area at all or settled in areas with poor infrastructure. Lack of empowerment of the farmers for decision, demolition of property without jurisdiction, and settling in not clean environment negatively affected the expropriated households' way of living. Such impacts have resulted from due emphasis only on the foreseen economic growth by the government side while ignoring mechanisms for sustainable development by accommodating the welfare of the expropriated households.

Similar to our observation previous studies carried out in Ethiopia showed that evicted people from their lands suffered landlessness, homelessness, and losses of cultural asset in Bahardar town of Ethiopia (Wubate, 2014). Elsewhere in the world it has been also shown that expropriation affects discrete economic rights or individual asset (UNCTAD, 2012). The policy makers should give due concern to these issues and integrate the local socio-cultural identity of the people into industrial development. The results of study discussants clearly showed that the variation of the consent of the expropriated households to change jobs emanated from the arbitrary nature of property valuation in process of land acquisition for industry development, which did not offer sustainable income generation. This is due to absence of standard procedures and responsible institutions for property valuation in Ethiopia as shown by some studies (Habtamu, 2019). In contrast various scholars recommend the need for strong institutions to monitor and protect property rights and enable independent valuation of land values (Gracia et al., 2013). In Ethiopia it is not only the lack of responsible institution which affected expropriated households but also lack of clarity of the compensation principles, which is neither indemnity principle nor "taker's gain" principle (Daniel, 2014).

The monthly income also supports the negative impacts of the land acquisition through expropriations where 72.4 % of the expropriated households have incomes that are below the poverty line. The worst case scenario was observed in 3.4 % of the expropriated households who do not have any income. After losing their farmland expropriated households go amiss in the menace of income paucity. This observation is consistent with previous reports that showed decreased income and increased expenditure after expropriation in Addis Ababa (Bahabelon, 2019) and deprivation of income and long-term landlessness in China (Wang and Qian, 2018).

In contrast to the expropriated households, the non-expropriated ones possess significantly higher total annual income that is estimated to ETB 212,416 than the expropriated counterparts (ETB 34,018). Previous studies also reported the occurrence of statistically significant difference in income, and overall expenditure between the expropriated and non-expropriated households in Northern Ethiopia (Woldegebrial et al., 2015) and elsewhere in the world (Parasuraman and Cernea, 1999).The effects of expropriation are beyond reduction in income and can also cause landlessness, homelessness, which culminates in migration to other urban areas where the migrants suffer from loss of social life (Wubante, 2014). However, if it is well managed land expropriation can improve income of individuals as shown in China (Wang and Qian, 2018).

Characterization of physicochemical indicators in industrial wastewater

The higher value of physicochemical parameters was observed for COD, BOD, EC, TSS, temperature, and pH during both dry and wet seasons in water samples in the Sabata area showed the risk of mismanagement of industrial wastes. Elsewhere in Africa similar findings have shown that the physicochemical parameters of water samples from gold mining zone in North-West Cameroon specially the pH and the concentration of suspended solids is quite high (Mambou et al., 2020).

The higher values of physicochemical parameters that were recorded for COD, BOD, and EC in water samples from downstream and middle stream of the Sabata River was an indication of water pollution owing to industrial industrial wastewater. Similar observations were reported where the pH of water used for irrigation from the downstream was above the permissible limit set by FAO for irrigation (Mohammed et al., 2021) suggesting the widespread pollution of water due to industrial wastewater from industries. Also in various parts of the world it has been shown that water samples affected by industrial wastewater revealed higher values of TSS, BOD, COD, and total suspended solids, which were above the permissible limit in Pakistani (Mohammad et al., 2020), India (Nirgude et al., 2013; Bhatia et al., 2018) , and Malaysia (Abu-Bakar et al., 2020).

Occurrences and impacts of heavy metals in water,soil, and vegetables

The concentrations of Mn, Ni, Pb, Cu, and Zn in soil samples were shown to be higher than the permissible limit of the WHO, USEPA, and EU for all land-use systems during dry and wet seasons in the study area. Studies conducted in Danbatta area of Kano State of Nigeria (Muhammad et al., 2021), Cameroon (Mambou et al., 2020), Pakistan (Mohammad et al., 2020), Kosovo (Malsiu et al., 2020) and Sri Lanka (Perera et al., 2017) showed similar results in which the concentration of heavy metals in soil samples tested were very high. The highest concentration was recorded for Pb in water samples from midstream during both seasons while the lowest concentration was recorded for Cu during the wet season and Zn during the dry season. The high concentration of heavy metals in the midstream of Sabata River is similar to the concentration reported from Cameroon (Mambou et al., 2020) and Ghana (Duncan, 2020). However, our results contradict with the reports of Perera et al. (2017) from Sir Lanka and that of Abu Bakar et al. (2020) from Malaysia.

The concentration of Cu, Pb, Zn, Mn, and Ni in vegetables grown on soils irrigated with industrial wastewater was statistically significantly higher than their concentration in vegetables grown on rain fed soils. Studies conducted in Bangladesh showed that the concentration of Pb and Ni in vegetables irrigated with untreated industrial wastewater is quite high (Mashuk and

Alam, 2020). The level of Pb, Cu, and Zn were found to be beyond FAO/WHO permissible limits in irrigated vegetables in Kenya (Rono and Wakhungu, 2021) further supporting our findings.

The results revealed that the highest BCF value was recorded for Pb in red beet during both seasons. Studies by Mohanty et al., (2021) in the Gujarat state of Ahmadabad town in India revealed similar results to our study in that geochemical factors regulate the metal transfer (soil-to-vegetable) than physiological factors related to vegetable types. Our observation is also in agreement with reports from China regarding the levels and transfer factors values of Cu > Zn > Pb in vegetables (Han et al., 2020).

The results of the analysis of the Total Target Hazard Quotient of non-carcinogens showed that a child who consumed lettuce and cabbage during the dry season was at higher health risk due to high accumulation of Cu and Pb in the area. The children were at health risks due to the high accumulation of Ni in cabbage, lettuce, and red beet in the area. This observation agrees with the reports of Mashuk and Alam, (2020) showing deleterious effects of heavy metals on human health in Bangladesh. Studies also revealed that Pb, Mn, and Cu caused a considerable health threat for adults and children as well as impacts of heavy metal pollution is global problem (Muhammad et al., 2021).

Mohanty et al (2021) also reported results that are similar to our findings in which very low HQ values of Cu, Ni, and Zn and high HQ of Pb and Mn observed in India .On contrary, in both adults and children, the daily amount of Pb intake through the soil-oral route observed in China did not exceed the daily tolerance set by the WHO (Han et al., 2020). Therefore, it is crucial to sustainably monitor and protect the environment to minimize the impacts of these toxic pollutants and devise a reliable policy and mechanisms of mitigation of industrial wastewater to ensure food safety.

Conclusion and Recommendation

Sabata town is known for its growing industrial pollution and the number of expropriated households as a result of the boom of manufacturing industries in the last three decades. However, the land acquisition for industry-induced compensation for the expropriated households was supposed to be not transparent, unfair, and not equitable to improve the welfare of the expropriated households. There has been no system in place to put the manufacturers under obligation to protect the environment.

Empirical evidences also showed that there are landlessness, loss of welfares, marginalization, social disarticulation, inadequate compensation that was misused, discharge of untreated industrial wastes into water bodies and/or terrestrial land, and an upsurge in unemployment in the area rendering the households inveterate shortage and loss of acquiring sustainable welfare means.This could have led the expropriated households to desperate lives and caused environmental pollution.

The impacts of land acquisition and compensation systems and environmental pollution on the welfares of the expropriated households should be considered by the policy makers to devise environmentally friendly and socially inclusive systems for industrial development.Attempts were made to analyze the socio-cultural impacts of industrialization on the welfares of the expropriated households and environmental pollution from the local, national, and development actors' perspectives.

The acquisition processes, however, affected urban, rural, and peri-urban household welfares through expropriation. The negative impacts of land acquisition through expropriation and factors aggravating the impacts have not been systematically explored in the country especially in Sabata town, where the majority of manufacturing industries have been established during the last three decades. Finally, the results of this study revealed that the expropriated households were economically and socially affected by the land acquisition processes for the industrial development as a result of arbitrary property valuation, lack of rehabilitation mechanisms, unfair compensation payment, and residing in inaccessible areas. These led them to increased expenses, decreased incomes resulting impoverishment of the households compared to the non expropriated households. The tempo-spatial analysis of physicochemical parameters of industrial wastewater from factories indicated water pollution affecting the surrounding community including the expropriated households. Furthermore, the tempo-spatial concentration of heavy metals assayed showed that water from middle and down streams, soil from different land uses, and different vegetable types in the area were affected suggesting the probability of health risks and high bio concentration.

Based on the study findings, the following recommendations were forwarded to counter the negative effects of industries on the welfares of the community and the environment and to promote inclusive industrialization for sustainable development.

1. The property valuation, compensation, and land acquisition processes need to be implemented through scientific approaches such as awareness creation; pre-planned residential replacements, provision of shareholding for expropriated households from the company, establishment of participatory and accountable valuation strategy; initiation of property valuation institution, and creation of a safe environment for the society.
2. The initiation of restoration strategies for the expropriated households' welfare through provision of welfare-improving funds; establishment of small business promotion, entrepreneurship development, and technology incubation cluster center; provision of finance

for a start-up business, training of expropriated on the financial management system, and provision of infrastructure and/or service facilities in settled area.

3. The regulatory institutions need to regularly monitor and evaluate the socio-economic impacts and mitigation strategies related to manufacturing industries, which is socially inclusive, equitable, and sustainably improve the welfare of expropriated households.
4. The existing environmental protection laws and regulations should be enforced as well as the transformation of industrial wastes into biogas products, and sustainable corporate industrial responsibility has to be established.
5. There has to initiation of standards for concentrations of heavy metals discharged into the environment;integrated and area-specific approach for the industrial waste management system (recycling, centralized or decentralized treatment plants) is needed.
6. The establishment of a resilient, safe, and sustainable industrial and environmental management system in the town through the implementation of green manufacturing industry and integrated industrial wastewater management system especially the restoring or recovering of the physicochemical and heavy metal from dumpsites to prevent further environmental pollution over surrounding settlements.

Finally, the study suggested further research areas to be considered

- Phytoremediation and phytovilotaization analysis of industrial wastewater
- The impact of industrial wastes on human and animal health
- Analysis of non-carcinogenetic, carcinogenetic, and mutagenic effects of hazardous industrial wastewater
- Assessment of the corporate social responsibility of firm owners
- Comparative analysis of the socio-economic contribution of the inorganic utilized industries and eco manufacturing industries

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Paper I Land acquisition, compensation, and expropriation practices in the Sabata town, Ethiopia

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Abstract

This study examined the factors that affect the industrialization driven expropriated households consent for change of job opportunity in Sabata town, central Ethiopia. The study employed survey questionnaires administered to 205 expropriated households,10 focus group discussion, and 19 key informants. The data collected were described using qualitative analysis and descriptive statistics. It was shown that land acquisition and expropriation for industrial development is on the rise in Sabata town. The study findings revealed that the expropriated households' has negatively affected by the displacement action through reducing job opportunity, curtailed their subsistence farming, and contributed to upsurge in poverty. Lack of decision power, demolition of property by court decision, and dearth of clean environment were also negatively associated with the expropriated households' to change job. The consent of the expropriated households to change job emanated from the arbitrary nature of property valuation for land acquisition for industrial development that did not offer sustainable income generation. Therefore, there should be initiation of property valuation institution and creation of safe environment for the society.

Keywords: Acquisition, Compensation, Ethiopia, Expropriation, Industry, Job.

Introduction

Inappropriate land acquisition/expropriation for industrialization has pushed farmers to poverty as lands are everything to farmers (Husen, 2018). Land expropriation is a critical issue throughout the world as it making them vulnerable to land grabbing and expropriation with poor or inappropriate compensation (Deininger 2003; Deininger and Byerlee 2011; Sitko et al. 2014). This is due to the fact that the constitutions of many countries give a legitimate power for the state to land acquisition for development projects (Larbi et al., 2004; Van Vliet, 2017; Li et al., 2017).

Although land acquisition system has improved urbanization and economic growth in China (Ding, 2007; Li et al., 2017), India (Narain, 2009; Li et al., 2017), Pakistan (Hull, 2008; Li et al., 2017) but led to several social, environmental, and health problems (Li et al., 2017; Lakra and Jangra, 2014; Ho, 2014; Kusiluka, 2011, ;Hui and Bao, 2013; Campbell, 2010; Fearnside, 2001; Jacobs, 2004; and Marco-Thyse, 2006).

Compensation for compulsory acquisition for land and buildings have been practiced on the basis of "willing buyer, willing seller" approach that welfare are specific to the people affected (Keith et al., 2008). Some countries used a replacement cost model for no clear market value for the land use for a religious building or spiritual purposes. The estimation of the compensation differs across the globe based on factors such as, the cost of the replacement land, the funds needed to make, the location and utility of the land, the nature of the soil and the level of development that exist in the area (Keith et al., 2009).

Compensatory payment was most often rejected by farmers owing to lower monetary values attached to land and their preference for non-cash assets (Ghatak et al., 2013).The property valuation for expropriated compensation is usually low or insufficient in amount (Viitanen, 2002; Tagliarino, 2017; Paradza et al., 2019; Shen, 2015; Paradza et al., 2019).

Land acquisition for manufacturing industries in Sabata town of Ethiopia has been based on compulsory land acquisition for industrialization and urbanization. The government plays major role as sole administrator and regulator of the land valuation or market. This emanated from the lack of standard and responsible independent institution for overall property valuation in Ethiopia (Habtamu, 2019).

The expropriation complaint of any damages or benefits associated with usually measured by assessing asset amount before and after method (Sevelka et al., 2019). The property valuation for expropriated households is measured by undervaluation, inconsistency, and ambiguity by estimators in the Ethiopia (Daniel, 2013; Daniel, 2009). Wubante et al. (2019) for example investigated land expropriation for urban expansion in Bahir Dar town depicted the expropriated people lost their produce and sources of income.

In an attempt to attract investment in manufacturing industries, particularly the foreign investors, the creation of job opportunity and technology transfer have been used as temptation in the study area. However, the industrial investors are “land Hungry” ultimately culminating in encroaching farmland and grazing land (Dessalegn, 2016). The impact of manufacturing industrial development on nearby farmers' land tenure and natural resources use were not sufficiently anticipated (Dessalegn, 2016). Land utilization and management system for manufacturing industrial investment, and ecosystem sustainability question should have been at the forefront of the debate for manufacturing industrial development. Landlessness emanating from expansion of industries became serious issue and yet it did not get due attention it deserves by local authorities.

The Ethiopian land management law has authorized the municipals to control the land. This might have affected the way of life of the land holders. So far a few studies have done in Ethiopia that assessed the effects of land acquisition for industry development, compensation payment, and expropriation on the way of life of the expropriated households. In particular, no comprehensive study has been done in Sabata town where the major manufacturing industries have been established during the last three decades.

The essence of international expropriation compensation reveals that the property owner's wealth status must be the same before and after the expropriation. Land expropriation is pervasive and contentious issue of the externalities of development that challenges landholders in course of proliferation of poor people landholding losers in the past decade. In this study area, the rural, peri-urban, and urban residents have expropriated from landholding for such industry development projects. Moreover, the past studies were not comprehensively analyzed the land acquisition, compensation, and expropriation practices for industry development. Therefore, this study examines the land acquisition, compensation, and expropriation practices for industry development in Sabata town. The study aimed to get answers for the following research questions (1)How do expropriated households lead their livelihoods? (2) How is the expropriated landholders/farmers consent addressed or expressed for the job change and for accepting fixed compensation payment? (3) Do the expropriated rural, peri-urban and urban residents have a job or resident afterward?

Analytical framework on acquisition, compensation and expropriation

Throughout this paper, expropriation is used to mean the depriving of the use right of land holding by eminent domain or judicial action for land acquisition for manufacturing industry development; however, it does not mean appropriation (Figure 2.1). The analyses of compensation payment were made with respect to various locations and a different time. The quantitative data was supported by qualitative data that was transcribed and analyzed to triangulate the quantitative data such as education level, satisfaction with compensation, mutual consent to property valued, allocation of land for home construction, settled in better infrastructure area and privileged of title deeds for construction house.

The Sabata town of Ethiopia farmers or urban residents does not have the Western mode of land ownership right. As per the farmland use law of Ethiopia, the land in urban or rural areas was under the ownership of public and farmers or urban residents have a use or landholding right respectively. Therefore, a rational farmer, peri-urban and urban residents were meticulously weighing the costs and benefits brought by changes in their job and residence after land takings for industry development.

The landholding has taken and acquired for the development of manufacturing industries by appropriate compensation payment in cash or giving replacement land. In the Sabata town of Ethiopia, a land taking for industry development was resulted in landholding loss of the basis of welfare for poor farmers without the provision of sustainable welfare improvement system. The expropriated households were lost their landholding and intangible asset due to land acquisition for manufacturing industry development in the area. This study was employed the minimum five interview due to the fact that it allowed all target interview to participate, easy to reach consensus and allow to get detail information.

In the process of land acquisition for the development of manufacturing industries in Sabata town, the factors that affect the welfare of expropriated households are the mutual consent of valuation, level education, settled in better infrastructure, conservation of cultural intact, privilege of construction house title deeds, resettlement or rehabilitation, dependent family members and satisfaction with compensation payment. In this regard, there is a problem of insecure job means and lack of the sustainable job acquiring strategy for the expropriated households. So, these analytical frameworks of the land acquisition, compensation, and expropriation practices to change jobs are discussed briefly in the Figure 2.1. It should be noted that some farmers or urban residents might lose their land but not their homes and they might be able to stay on as farmers, landless, joblessness, wage employees, beggars, migrate to other places, marginalize and impoverished people. In this study, we only analyzed the farmers, peri-urban and urban household's residents who lost partially or total their landholding for the development of manufacturing industries in the Sabata town.

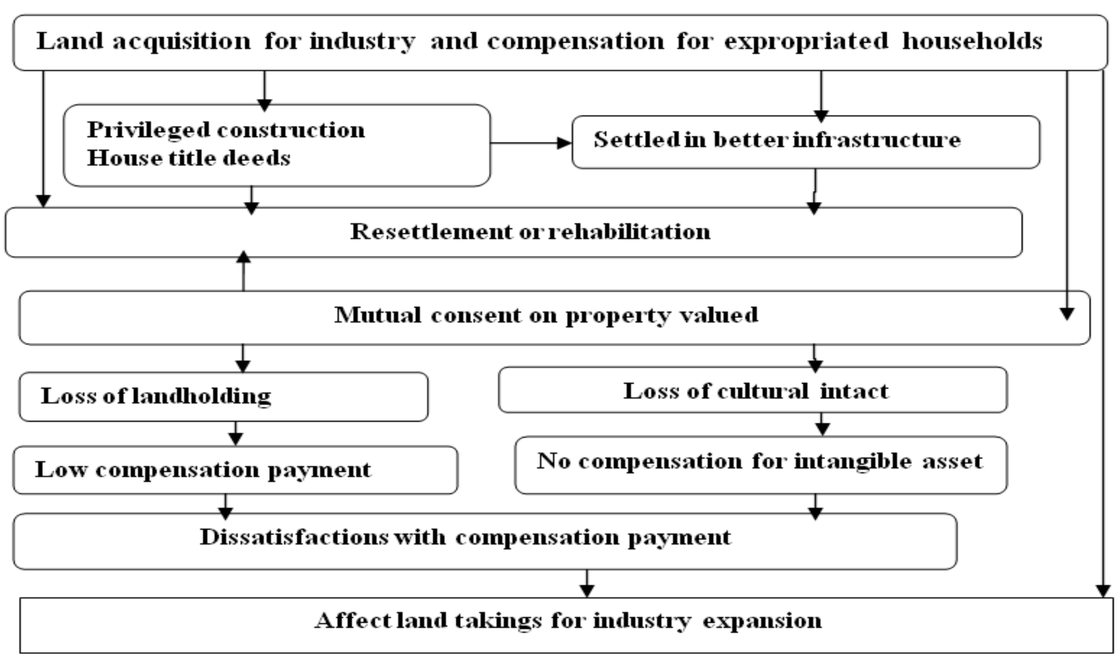

Figure 2.1 Effects of industry expansion on means of living of expropriated HHs

Research Methodology

Description of the study

Sabata is a town located in the Oromia Special Zone Surrounding Finfine of Oromia National Regional State. The town is the capital of Sabata Awas District. It is located about 25 km south of Addis Ababa on the main road to Jimma. During the last 29 years, the town has been under the boom of industrialization. This has resulted in engulfing of peri-urban and rural farmland acquisition for industry development. The total land size of the town was 2.1 Km^2 (1994), 7.41 Km^2 (2011), 9.9 km^2 (BoFEDO, 2014/15), and 17.5 Km^2 (OUPI, 2019). This indicates an increasing trend in the urban land size used for industrial development and other development activities. According to the information acquired from Sabata Investment Office, operational manufacturing industries are using a land size of 145.85 hectares in the town.

This town is one of the old towns whose industry growth and expansion rate are also the highest among other towns of Oromia Special Zone Surrounding Finfine. Hitherto 2019, particularly in the Northern, Western and Southern periphery of the town was the eviction of farmers and allocation of land for industry increasing at an alarming rate and lead to the expropriation of farmland that was used as the mainstay of their livelihood. However, once upon a time the industry expansion arrived there, the peri-urban and farmers way of life and settlement patterns were changed and last parted with pioneers' land expropriation. Finally, it resulted in the loss of land of their mainstay for sustainable income generation and livelihood means.

Research Design

Survey research methods were employed for data collection. This study utilized a post hoc research design. All expropriated households were traced to their present place of habitation, and their condition was assessed. The practice of land acquisition, compensation, and expropriation by industry development was assessed by analyzing post displacement conditions. For the expropriation, a comprehensive socio-economic and demographic situation assessment was carried out on sampled households destined to be displaced.

This study employed the mixed methods of both qualitative and quantitative approaches. A household survey was conducted on 205 expropriated households sampled through strata sampling techniques. Furthermore, the primary data was collected through a survey questionnaire, key informant interview, focus group discussion, and field observations while the secondary data was obtained from different written and documented sources. Additionally, a desk review was employed.

Focus group discussion and key informant interview

Household surveys generated quantitative data on the impact of displacement and resettlement on economic and social conditions. However, the surveys were designed to provide a full assessment of land acquisition, compensation, and expropriation practices and processes. Furthermore, the household surveys, in all manufacturing industry projects qualitative data were collected from various focus groups and key informant interviews.

The focus group discussions were conducted after the official records and household surveys had been analyzed. Analysis of official documents and discussions with officials provided an understanding of the land acquisition, compensation, and expropriation process from the government's viewpoint.

Sample Size

The sample size estimation used in this study took into account the number of expropriated households in the study area. The total number of expropriated households was 3,665 of which 1000 were expropriated by operational manufacturing industries during 1992 - 2017/18 (Central Oromia Displaced Community Development Affair Agency, 2018). Based on this baseline data, this study used a Kothari (2004) formula to estimate the sample size needed. Accordingly 240 households affected by the industrial development were selected. Out of a total of 240 households included in the study, 205 responses of the respondents were complete responded ones. The response rate was 84.4 %. The rest 14.6 % was the incomplete response and rejected responses. This study also used qualitative methods to collect data from five individuals of 10 groups (50 persons) using FGD and five individuals of 19 groups (95 persons) using KII making a total of 29 groups (145 individuals).

Data analysis

The survey data were analyzed by using descriptive and inferential statistics for quantitative data and concurrent triangulation was used for the analysis of qualitative data including land acquisition, compensation, and expropriation practices. For the descriptive statistics SPSS version 21 and Stata version 14 were employed to test the significance of associations among variables used in the study and the welfare of the expropriated households. The analyzed data were summarized and presented by using different kinds of illustrations, statistical tables, graphs, and charts.

At each stage of discussions, the secondary information obtained from different sources was also included in the analysis. On the other hand, qualitative data from KII and FGD were transcribed, categorized, enumerated, looked for relationships, and interpreted. The qualitative data via KII and FGD were qualitatively analyzed and integrated to support the survey results for triangulation purposes as suggested by Guba and Lincoln (1985).

Results

Socio-demographic characteristics

The explanatory variable and control variable of expropriated households of urban, peri urban and rural areas effects to land acquisition for industry development were the main variable in this study. The main explanatory variables were categorical variables indicating the status of the education, sex of household head, mutual consent, settled in better infrastructure, rehabilitation process, satisfaction with compensation, and acquired land for construction of houses. Interviewees indicated that the modes of compensation were valued by adhoc committee with no or sometimes participate in the process and the government is not responsible for jobs and residence for partial or total land losers. Therefore, this survey provided us a good source of data to discover the process of land acquisition for industries led effects of expropriation.We controlled for other factors that may affect the individual's expropriation, mainly including gender, age, and other family factors such as family size, family income per-capita and family housing. Table 1.1 provides an overview of socio-demographic characteristics of descriptive statistics of the variables used in the empirical analysis.

From Table 1.1, we can see that the average consent of expropriated households for land acquisition process was 1.9626, which reflects that the consent status to land acquisition system was unwilling, which was consistent with the previous literature on the consent of farmers to change job. The average land size taking was 0.5611, which shows that land-lost farmers accounted for about half of the hectare of land loss of the total sample. The average age of rural residents surveyed was 48.29 years old and the average level of education completed was 3.5145, which is a primary school of the total sample respondents. The average number of dependent in the family size of respondents was 1.7996.

Table 1.1 Variable descriptions and descriptive statistics

Variables	Mean	SD
Dependent		
Land acquisition process	0.9626	0.6343
Independent		
Land size lost	0.5611	0.9999
Age (years)	48.2900	14.8504
Martial statues	2.0824	0.5260
Religion of HH	1.6147	0.9406
Number of dependent members	1.7996	1.1649
Level of education HH head	3.5145	.6422
Mutual consent to compensation	1.8364	0.3953
Satisfaction with compensation	1.8645	0.3694
Settled in better infrastructure area	3.3981	0.6421
Privileged construction land title deeds	3.2607	0.6042

Land size takings

Between 1991 and 2018/19, total of 3665 households evicted and included in urban boundary and of which, more than 1000 expropriated households for industry development in Sabata town (Oromia Displaced People Development and Rehabilitation Agency, 2019). The information acquired from Sabata Town Municipality Office revealed that the administrative unit of Sabata (1998-2006), Alemegena (1998-2005),Walate (1995-2005), Furi (1992-2005), Dima (1995-2005), Roge (1999-2007), and Karabu (1995-2007) are allocated 57.5 ha, 5.54 ha, 3.3 ha, 55.14 ha, 44 ha, 8.22 ha, and 53.1 ha, respectively were allocated for development of manufacturing industries in the study area (Annex 1.2).

As indicated in Table 1.2, among households with land holdings, the average land size for both expropriated and non-expropriated households are estimated 80 % ranges 0.01 to 0.5 hectares. The respondents of non-expropriated households have 59 (24.2 %), 11(4.5 %) and 7 (2.9 %) have a land size of 0.5 ha, 1.51-2 ha and above 2.1ha respectively. On other hand, expropriated households of 46 (22.4 %), 1(0.5 %) and 0 % have a land size of 0.02 ha, 1.51-2ha and above 2.1ha respectively. So, 59 (13 %) non expropriated respondents have landholding size of 0.5ha, whereas 46 (22.4 %) respondents of expropriated HH have a land size of 0.02 ha. However, only 3 % of the expropriated households were landless due to landholding takings for manufacturing industrial development.

Table 1.2 Percentages distributions of respondants by landholding size in hectares

Type of resident	obs	Land holding (ha)									
		landlessness		0.01-0.5		0.51-1		1.51-2		2.01 & above	
		No	%	No	%	No	%	No	%	No	%
Non-expropriated	244	0	0	177	39	30	7	20	4.6	17	3.8
Expropriated	205	13	2.89	18	41	5	1.1	2	0.45	0	0
Total	449	13	2.89	36	80	35	8.1	22	4.51	17	3.8

Land acquisition

Procedures of land acquisition

The focus group discussion and key informants interviewee depicted that land acquisition for industrialization was a haphazard type of land allocation for industry development that was not based on social and environmental impact assessment of the community and environment of the area. In the acquisition process, the procedural safeguards and compensation in case of expropriation have followed the phases that illustrate a typical expropriation process (Annex 1.3). This process was explicitly prevailing for payment of compensation in cash and/or kind in the area. These are regulatory practices of land expropriation for public purposes such as manufacturing industries covered are summarized in annex 1.2. Landholding trajectories come to play a vital role in identity maker, sustainable welfare asset, sense of autonomy, rootedness, opportunity, social space, spiritual inhabitance, and culturally intact. Escobar's proposition constitutive development has to be inclusive.The possibility of increased counter-litigations and potentially handcuffing the ability of local government to perform their constitutionally delegated power in a practicable way in the context of an ever-globalizing world.

The land is a means of an income generator and welfare security for farmers in Ethiopia. The township, which is Sabata, is in the jurisdiction of an Oromia National Regional State of Oromia Special Zone Surrounding Finfinnee that acquired its urban status in 1994 (Annex 1.4). Before I decided to select the site, the pre-assessment was done through an interview with local villagers and thus, I got the idea that no sooner had I concluded my interview when voices roared from the interviewee. I was bombarded with bitter accounts of the ongoing land expropriation in their community.

Land acquistion for manufacturing industrial development in Sabata town has proceeded at a phenomenal pace since the late 1990s, and this has been estimated averagely in a continuing loss of farmland amounting to hundreds of hectares of land in the area. The interviewee stated that in the perception of economic growth and accommodation of a large number of unemployed people prompted a fervent growth of manufacturing industries and urbanization on the onset of land development was marked by the urbanization that took off in the 1990s.

Land expropriation is described as a form of “government behavior" using coercive measures to acquire private landholding under the compensatory arrangement by the government in the public interest or public purpose (Annex 1.4). Thus, the firm owners are acquired land for manufacturing industries development from the government on a lease or rent contract basis for at least 60 years in the country. It is visible that the expropriated poor rural and urban communities in Sabata town continue to languish in poverty.

Indicating variables of the land acquisition process

As indicated in Table 1.3, the study was carried on sampled 205 expropriated households for each determinant factor of the land acquisition to the industrial establishment. From the sample households, 80 % of households revealed a decrease of landholdings as a result of land takings for industrial establishment. On contrary, 82 %, 78 %, and 68.3 % of the respondents are dissatisfied with property valuation, unwilling to change jobs, and most culturally intact due to landholding takings for manufacturing industrial development. However, small numbers of respondents of 4.4 % are satisfied with the property valuation process as a result of land execution for industrial investors. Furthermore, some of the respondents revealed that 23.1 % of households landless as a result of land acquisition for manufacturing establishment in the area. Overall, out of 205 sample respondents, 20 % stated that the availability of basic culture intact after expropriation in the area.

Table 1.3 Effects of expropriation

Variables	Expropriated households		
	Response	No. of respondents	%
Change way of livings	Agree	184	78
	Not agree	21	22
Satisfaction with property valuation	Very dissatisfied	169	82
	Dissatisfied	3	1.5
	Satisfied	9	4.4
cultural intact	Intact basically	40	20
	Some disappear	16	7.8
	Most disappear	140	68.3
Landholding size	Decrease obviously	164	80
	landless	48	23.41
	Increase slightly	0	0

Compensation practices

Method of property valuation

The total area of Sabata city was 9,827 hectares in 2008, which became 17,503 hectares in 2018. The increment was by 7676 hectares (OUPI, 2019). The urbanization and industrialization has resulted in expropriation of urban, rural, and peri urban people and thus, it needs compensation payment with the current market price of the available property.

For property valuation and setting compensation rate, data was collected from production and productivity in the area from Sabata Awas District and Sabata Town Agriculture Office, Trade and Market Development Agency, and experience from neighboring towns to improving compensation rate for expropriated households.Accordingly, the indicators used were productivity of Teff per hectare, agro-ecology, and production and productivity per hectare/price. The production and productivity per hectare/year/price from 2014-2019 were used for the analysis**.** As a result, the standard of nominal land price per m^2 were 0.70 birr/m^2, 5.5 birr/m^2 and 18.75 m^2 used during the period up 1998, 1999 to 2003/04, and 2014 to 2018 respectively. However, the nominal rates from 2005 to 2013 were changing over time, sometimes 8.6 birr/ m^2 and others 15 birr/m^2. It is not clear to know why it is so changing time to time. So, the Sabata town municipality has made an amendment to estimate of the compensation rate of one m^2 of land for crop production estimated using the addition of consecutive five-year production divide into five years with an average production of five years of 39.40 kg, the current market price of 100 kg of teff birr 2900, estimation of compensation payment for 10 year for 1 m^2 as birr 114.26 in 2019 (Table 1.4)**.**

Table 1.4 The process of improving compensation rate in 2019

Type of crop	Year	Estimated Production /hectare	Price Br/100 kg
Teff	2014	37	1850
	2015	38	2100
	2016	39	2200
	2017	41	2400
	2018	42	2900
	Average	39	2900
Estimated compensation rate for crop production per $m^2$10,000		39.40 x 2,900 X10/10000	114.26/m^2

The amount of compensation and land holding takings were only about acquired data from Sabata town Land Development and Management Agency (2019) of 1115 expropriated households only. Overall, the amount of compensation paid for 1115 households were 45.2 million birr for 1,098,674.94 m^2 of land size takings from local communities for industrial development and others services sectors (Table 1.5).The available data on compensation showed that for 862 expropriated land holding of 4.2 hectares, 1.586 million birr of compensation paid in cash in Dima, Dalati, and Karabu areas.

The amount of compensation payment revealed arbitrary and not based on area specific. This can be evidenced that 53 and 15 households from Roge Atebella and Karabu at Dhanqu site were paid compensation in cash of 1.25 million birr and 3.42 million birr for land size of 22.7 and 8.2 hectares of land holding takings respectively. This indicates the compensation paid is not take in to account family situation, inflation rate, number of family, meet sustainable food security, arbitrary, and thus, rather engulf or intermesh the poor to poorer/beggar.

Table 1.5 Method of property valuation for compensation payment

Name of site	Number of expropriated HHs	Type of crops	Production/ ha or m^2/birr	land size (m^2)	Total Production /year	Nominal price/100 kg(ETB)	Estimated Annual revenue/ Year (ETB)	Estimated revenue for 10 year (ETB)
Dima, Dalati & Karabu area	862	wheat	-	42043	-	-	-	1586164.5
Roge	57	Teff	37	249770	924	1880	1737402	17374018
Roge Atebella	53	Land size	5.5	226933	-	-	-	1248132
Karabu at Dhanqu	15	Teff	26	81537	212	1612	341737	3417369
Karabu at Darto	9	Teff	37	98,827	361	1880	677703	6777025
Walate at Ajamba	9	Wheat	47.7	27821	132	7365	08360	1083593
Dalati at Hambisa	110	wheat	45.8	371745	1704	802	1369226	13692261
Total	1115			098675				45178562

Interviewee with key stakeholders revealed that the procedure of property valuation was vague. This situation exposed the whole procedure for nepotism and corruption. Besides, actors involved in valuation process have less skills and knowledge about the plot of land they are evaluating. Not only was this but also there was not the standard for land valuation based on spatial location and others. For instance, the compensation rate per m^2 of land size in Sabata town was 0.70 birr in 1997/1998 and 5.40 birr in 2000. Respondents argued that the demographic dividend of workforce aged between 15 to 24 years can be an asset or credit based on the way we utilize it. Every year in Ethiopia, it was estimated that 1.2 to 1.5 million youngster or people per year added to the country and engulfed into the seeking of job. It is also said that like wearing white socks with black shoes. It is mandatory to develop or integrate primordial or indigenous identity into industrial development. The primordial identity to industrial development justice has to be considered.

The development policy makers must be eyes behind the shoulder of poor expropriated households in execution of development process or plan in the country. It is also vital to define the boundary in development endeavors between state and people as well as state and economy.In the past 27 years of development process, the government has given concern only to economic growth of drawn private companies' upper hand; however, it ignores means of acquiring sustainable improvement of the welfare of the poor expropriated households. It is known that manufacturing industries can be created unlashing job opportunities. However, it requires different yardsticks to improve the welfare of expropriated households from their basic welfare base of landholding in the area.

Furthermore, property valuation for expropriation is used as the techniques to ascertain the market value of peoples landed property assets for compensation. As Standards Council of Canada of ISO 19152:2012 of Land Administration Domain Model (LADM) defined land as:

> *"The surface of the earth, the materials beneath, the air above and all things fixed to the soil. The land administration includes informal, customary and formal uses and property rights (Lemmen et al., 2019)".*

However, the interviewee revealed that the compensation payment for expropriated households for public purpose in Sabata town was not taking into account the materials beneath, the air above and all things fixed to the soil underneath as per LADM. This indicates unfairness of compensation payment and paid compensation not improved the change job of expropriated households in the area.

Expropriation

Vice and virtue of expropriation

The farmland and urban land are the most important physical capital for both expropriated and non-appropriated households for their welfare. However, the FGD with expropriated households stated that manufacturing industry owner after land acquisition become less concern for citizens, bullet in the human body that make disable after a time, make poorer and factory guard, make expropriators to see factory like snake staring a frog, expropriators like the hen rights on land, industry that not accommodate rural and urban residents and thereby need mutual expropriated households welfare improvement Fund (Government & Stakeholders). The discustants with the expropriated households' views on their landholding takings for industry development quoted as follows

"Laftii lafee dha.
Namni lafee hin qabne nama hin tahu.
Namni lafaa hin qabine, Afaan hin qabu.
Nutti mirga lafa irratti qabinu, mirga lukkutti.
Translation of the above quotation as follows
Land is our bone
If you have not bone, you could not be human
A person who have no land, he or she has no voice
We have a right on land equal to a right hen have on land"

However, most of firm owners focus on their profit maximization rather than accomplishing corporate social responsibility effectively and efficiently. The land expropriated households are not offered the economically appropriate compensation for their previous landholding.

Satisfaction or dissatisfaction with compensation payable

The study results revealed that 185 (90 %) the respondents ‘not satisfied with compensation payment for expropriated households. Similarly, 184 (89.8 %) of the respondents are not rehabilitated for acquiring sustainable job (Table 1.6). Several respondents were not consulted and settled in better infrastructure area after expropriation. Concurrently, the FGD and KII participants indicated that there is no prior plan, social and environment impact assessment, participation in property valuation and compensation decision, recognition of objectives of change job rather than showing the border of our land holding for measurement; telling type crops, houses, fence, livestock and perennial fruits, available and amount of production per hectare for expropriation.

Table 1.6 Factors that affect government and promoters for land acquisition

Variables	Responses			
	Yes	%	No	%
Resettlement or rehabilitation	21	10	184	89.8
Landholders consultation/mutual consent	23	11.2	82	88.9
Satisfaction with compensation	20	9.8	185	90
Settled in better infrastructure	93	45.4	115	56.1
Privileged land holding certificate	144	70.2	64	31.2

Effects of expropriation

The study found out that about 63.1 % of expropriated households resettlement after land acquisition for manufacturing industries (see Table 1.7). The inquiry related to degree of agree to settled in better infrastructure area after expropriation for industrial development; 66.8 %

expropriated households indicated that not settled in better infrastructure area after land acquisition for industry development. Similarly, the main bottleneck for change job for expropriated households to improve way of life as per findings from Likert scale is not agree of landholders satisfaction with compensation payment (71 %) after expropriation. The study depicted that 49.1 % not agree with the privileged land for construction of houses to expropriated households. However, the boom of manufacturing industries in the area has been constrained by dissatisfaction with compensation payment, disappearance of most of cultural intact and decrease of land size of homestead for acquiring sustainable job.

Additionally, from FGD and KII, we learned that landholders not mutual consent for land acquisition and dissatisfied with industrial projects due to land speculation or corruption in compensation calculation; no improvement of compensation rate for more than 10 years; residents illicit and informal land markets with dividing into small parcels and informal land transfer(“sell”) at good prices to maximize benefit from their landholdings for both expropriated and non-expropriated residents; inappropriate at outskirt of urban land psychological expropriated; disregard of property valuation (i.e. the inflation rate, children less than 18 years old, disabled, old age, and life expectancy), manufacturing industries lease period (60 years), paying insignificant amount of compensation payment in cash, arbitrary compensation computation that not due concern local condition, disregard of intangible asset such as cultural intact disappear, and lack of sustainable improvement fund for expropriated households welfare have contributed considerable impact in development of manufacturing industrial ventures.

Discussants and interviewees pointed out that when there is request for manufacturing industrial investment, the government expropriated land from peri-urban or urban fringe farmers and urban residents in the name of public purpose. They are also added that not agree to land takings for industrial investment; government labeled as anti-development and may also take to jail. Thus, whether you believe it or not, if the landholding is required for industrial investment, it is not possible to say no rather than taking small amount of compensation payment in cash.

Table 1.7 Percentage distributions of expropriated households by level of satsifation with compensation and underlying factors

Change way of life	Response		Variables				
			Mutual property valued	Satisfication with compensation	Resettlem ent	Settled in better infraructure	Previlaged in land for house construction
Very not agree	Yes	Fr	0	2	30	2	31
		%	0	0.9	14	0.9	14.5
	No	Fr	31	1	1	29	0
		%	15	0.5	0.5	13.6	0
Not agree	Yes	Fr	29	152	29	21	105
		%	14	71	13.6	9.8	49.1
	No	Fr	135	11	135	143	56
		%	63	5.14	63.1	66.8	26.2
Not sure	Yes	Fr	6	3	0	0	4
		%	3	1.4	0	0	1.87
	No	Fr	1	4	7	7	3
		%	0.45	1.87	3.3	3.3	1.4
Agree	Yes	Fr	1	2	1	2	7
		%	3.3	0.9	0.45	0.9	3.3
	No	Fr	3	8	9	8	3
		%	1.4	3.7	4.2	3.7	1.4

Discussion

Industrial development is inevitable activity for nations worldwide. Since development of industries is often based on the land owned by the public that conflict between the landholders and firm owners or promoters are common. The approaches to the handling of the conflict and the mitigation strategies require better understanding of the socio-cultural and political dynamics of the community.

Particularly the aptitude and knowledge of the local community is vital. This study explores the situation of land acquisition for the establishment of various industries in Sabata town, central Ethiopia. The consent of the community in the area is investigated along with the factors affecting. Several research results have shown that variation in the consent of expropriated households to change job and residence as result of development projects such as manufacturing industries. The present study found that those households who became expropriate did not recognize the benefit of losing their land for the establishment of industries. The occurrence of negative statistical association between the aptitude of the expropriated households and firm owners is an important factor affecting the evicted households to change job. This suggests that the knowledge of the households to expropriate is very important. In consent to our observation Li et al. (2017) the knowledge of farmers about expropriation was positively associated with the farmers' willingness to change employment in China. These authors also found that the farmers' knowledge of land expropriation is less than 10 % significance test. The land-expropriated farmers had non-agricultural jobs arranged in the city.

This situation was shown to increase their consent significantly (Li et al., 2017). The results of this study, however, did not reveal such satisfaction by the expropriated farmers. This might be due to the fact that the participation of the expropriated households in China is better than that of Sabata to change job and residence. Another possible explanation for this is that expropriated households' willingness to change job and inhabitance in China might got more recognition and awareness about the significance of change in employment than expropriated households in Sabata town of Ethiopia.

This study revealed that the provision of title deeds effects on expropriated households' consent to change job positively affected to change of job. This finding is consistent with the importance of residential complexes and household industries having a positive effect bearing on agricultural land use patterns in Delhi, India (Firdaus & Ahmad, 2011). The possible explanation for these results might be the allocations of construction land with title deeds improve to adapt to complex and expensive rent of houses in the town in both cases. This factor may explain also the relatively good correlation between acquisition of title deeds increasing willingness of expropriated households to change job and residence in both areas.

One interesting finding is that the empowerment for decision to change job and residence showed negative correlation with the consent of the households in this study. Importantly 82 % of the respondents were very dissatisfied with compensation payment in the area. This observation is supported with evidence from previous observations (Balachewu, 2009; Achamyeleh, 2014; Amare et al., 2017; Achamyeleh, 2020). In contrast, in China the government empowered farmers to negotiate directly with land users for expropriation and land use efficiency in the process of land acquisition and public leasing system (Cao et al., 2008). The results of this study showed that the benefit obtained from compensation paid for evicted peri-urban land was too low and the households were dissatisfied with it. This might have arisen from property valuation process of the land, which has been done by non-professionals without the consent of the evicted people.

Besides, there has been no special support for recovery and rehabilitation, no livelihood improvement fund, the process has not been participatory and the valuation of property has been unclear, the valuation process did not consider inflation and life expectancy, the compensation payment fail to comply with the lease period, did not provide any shareholder for evicted people from the industry established, unvalued intangible assets, unvalued psychological or moral damages, no special support for children less than 18 years, old men and disabled people, and no land substitution given to the expropriated households. These factors may explain the prevalence of negative aptitude and dissatisfactions of the households on the expropriation and compensation payment for development of manufacturing industries in the area.

Similarly, dissatisfaction of the expropriated households has been reported by previous authors from Ethiopia showing that the compensation paid was inadequate; the preference of the households to be land substitute than cash; payments being not given on time, complaints appealed dissatisfied for not well treated, and lack of training after receiving compensation payment (Amare et al., 2017). This clearly showed that here has been growing land dispossession accompanied by inadequate and ineffective compensation packages resulting in impoverishment through urbanization and industrialization (Efa and Gutema, 2017). This showed that an expropriated household’s led industrialization is a failed approach to establish a comparable means of income earnings and considered asset depleting consumption style (Leulsegged et al., 2011). Previous studies done in six towns of Ethiopia showed that 41.7 % of households did not participate or were unaware of expropriation of their land (Amare et al., 2017).

This contradicts the participatory nature of expropriation for development, which should be inclusive development, voluntary bargain, consent of land user or owner, cash compensation, replacement land from other areas, and reserving reasonable plot of land as described (Achamyeleh, 2019). The absence of arrangement of alternative income generating jobs and lack of technical and administrative development of skills for the expropriated households had aggravated the situation in some towns of Ethiopia such as Bahir Dar and Debre Markos (Sayeh and Mansberger, 2020). This could have made the expropriated households to be unwilling to change job and residence due to undervaluation of their land by the compensation process of land acquisition and leasing system; the corruption leading to inequitable benefits; distortion in the measurement of landholding property for compensation; and not empower landholder to negotiate with land user in process of valuation property for compensation payment.

Efficient and equitable compensation, which has been obtained through a market transaction and bargaining negotiations has been practiced elsewhere with success (Zou & Oskam, 2007), and granting farmers negotiation power directly with land users during urban expansion (Cao et al., 2018). Though in Africa the property right dominance is customary, the empirical evidence regarding market value was used as the basis for the compensation for expropriation. Various ontological and methodological factors limit its utility and resulted in inadequate compensation payment and impoverishment of expropriated households (Kabanga & Mooya, 2018). The process of new urban built up property formation in the transitional peri-urban areas of Ethiopia resulted in the land use conversion through informal and formal market channels (Achamyeleh, 2020). Our findings raise intriguing questions regarding the nature and extent of land acquisition and compensation process for sustainable improvement and recovery of expropriated households for manufacturing industry development. The present study revealed that demolition of property by court decision had negative association with expropriated households' consent to change job and residence. This finding is consistent with expropriations reported in Rwanda that had resulted in many evicted households expressing dissatisfaction with the process (Rose et al., 2016; Hoops et al., 2019).

The results of this study showed that enjoying clean residence environment had significant negative association with willingness of the expropriated to change job and residence. This finding is not inconsistent with the results of Li et al. (2017), who observed that the environmental variable and the farmers' consent showed significant positive correlations to change employment and inhabitance. Moreover, land expropriation had a negative impact on the land-lost farmer's health through income and psychological impacts (Wang et al., 2019). This might be due to fact that the property system is bifurcated into rural and urban landholding systems, are allowed to exercise of rural usufruct holding only without power to transfer and change into non-agricultural uses and urban land leasing holding rights through auction or rent basis (Achamyeleh, 2020).

This study revealed that 68.3 % of the respondents stated the expropriation process as disappearance of cultural intact. These findings are rather disappointing. These findings will doubtlessly be much scrutinized, but there are some immediately dependable conclusions for inadequate conservation for cultural intact of expropriated community after landholding takings for manufacturing industry development. This result is consistent with those of Li et al. (2017) the land-expropriate farmers did not care about the scenery and its regression coefficient is insignificant. Corroborate the ideas of Li et al. (2017) and Wang et al.(2019) suggested that the scale of the social network has a significant negative correlation with the willingness to move. Thus, the findings of the current study support the results of the previous researches.

Demolition of property of expropriated households by court decision, the education level of the expropriated households and empowered for decision are factors affecting willingness of the households. These results are consistent with other researches which reported that the education level, households size, the main types of family employment, the proportion of non agricultural income, the relocation infrastructure, the mode of relocation, and satisfaction with the compensation policy have a significant positive correlation with the willingness to move (Wang et al., 2019; Li & Xi, 2019).

The study results depicts that variation of consent of expropriated households in change of job after expropriation such as settled in clean environment and entitled land for house construction record that the probability of increasing the consent of evicted households in Sabata. This study result in accord with recent studies indicating that the compensation policy for displacement in the process of industrial development affect the willingness of the owners to convert them to alternative uses (Ghatak & Mookherjee, 2011).

Generally, the results of this study revealed high rate of urbanization in small and mid-size towns in OSZSF backed by proliferation of investment activities accompanied by multitudes of delinquents such as land expropriation without adequate compensation, loss of productive agricultural land and others in agreement with previous reports (Dejene & Bhangoo, 2018). Similar to our observation study done in Bangladesh where compulsory purchase procedure misusing legal rights by the government authority by using inequitable acquisition of immovable property ordinance, no protection given for religious place and graveyard, and imposing unfair curtailment of rights for getting fair compensation (Rahman, 2013). The trends of spatial justice (procedural, recognition and redistributive) concerning the current real property expropriation practices in Kigali city of Rwanda showed a decreased redistributive justice in the compensation and the increase in the displacement effects of expropriation (Uwayezu & Vries, 2019). The online mailing interview with Viitanen, Professor of Real Estate Economics and Valuation, Helsinki University, Technology Institute of Real Estate Studies (March 25 , 2020) stated that the Wiiala thought was mainly concerned about the compulsory purchase and compensation for agricultural and forest land based on Finnish and Swedish legislation and experiences, whereas Denyer-Green is a British researcher and he is strictly concentrating on British legislation and court cases (case law) and more in situation in cities and villages too.

Similarly, it is clear that local government's increasing appetite for revenue and urban precocity resulted in offering inadequate compensation to land-losing peasants and thus, had negative implications for households' well-being in most areas. In consent to this study done in China showed similar effects (Zhang & Zhang, 2019). These studies further explained that health status of land-lost farmers is significantly worse than that of those with land (Wang et al., 2019). The people in Ethiopia have not been fully realized guarantees about common ownership of land (people and government) in terms of land accessibility; enjoy ability, and payment of fair compensation in the event of expropriation (Daniel, 2013). The Ethiopian constitution excludes land as a subject of compensation and has no value for the landholder.The denials of compensation for rural and urban landholders are contradicting with the very principle of joint ownership of land by the people and the state (Daniel, 2013).

The study results depicted that more than 50 % expropriated households were not aware of the importance of industrial establishment, were not consent to change job and dissatisfied with low rate of compensation payment made and about the property valuation made by State. According to the results of key informant and focus group discussion property valuation for land acquisition for industrial development is arbitrary and did not offer sustainable income generation.

Similarly, studies results revealed that in the process of determining and implementing compensations arbitrary, ad hoc, complaints of preclude their rights or participation and this is in agreement with the situation in India (Ghatak & Mookherjee, 2011). The land valuation for the expropriated households were based on the legal price called "State price" that was fixed by government body allowing very low compensation. This has been reported previously in various regions and towns in Ethiopia (Nigussie et al., 2012; Alemu, 2013; Amare et al., 2017). Such decisions have led the expropriated farmers to be deprived of appropriate social security once the compensation is used up and face the dual pressures of life and employment. This is in agreement with the reports published elsewhere in the world (Wang et al., 2019). The results of our study is also consistent with the results of studies carried out by World Bank in Nigeria in which the local landholders view expropriation as a system for changing the poor to very poor and elevate the rich to the richest (Deininger et al., 2011; Hoops & Tagliarino, 2019).

The results of this study conform to the development Induced Displacement of Households by Railway Construction in Dukem due to inappropriate property valuation and corruption (Bikila, 2019). It is in contrast with the European Convention which state that no one can be dispossessed their landholding right or usufruct right unless for the public interest (Viitanen, 2002). In contrast, this study showed that design of alternative scheme to restore affected households prior to acquisition of land for projects in Dare Salaam of Tanzania (Msangi, 2011).

The expropriated households were unwilling to change employment and residence. The cultural intact was affected by industrial development in Sabata town. This study explained that a property owner may be unwilling to utilize their property in accordance with the land use planned and needed for industrial development (Kalbaro et al., 2008). Additionally, Jacques Diouf described the poorer states producing the food for the richer at the expense of their own food security, and an upsurge of the economic pillar of sustainable development at the expense of the social pillar i.e loss of social equity in land rights (Velpuri, 2009).

Conclusion

Like most sub-Saharan African countries there has been mounting competition for land in urban and peri-urban areas for the development of manufacturing industries. The municipality of the Sabata town has been using “expropriation” as a tool for land acquisition through property valuation and compensation payment for development and manufacturing industry. As a result of this urban and peri urban land becomes the heart of demand for the development of manufacturing industries.

Land acquisitions for industrial development are vital for economic development with taking into account the mutual benefit of the expropriated households and industry owners. However, the process of land acquisition and the absence of training and skill in managing new way of life and business had affected the expropriated households. The provision of title deeds for expropriated household’s consent to change job is positively associated with change of job and residence. One interesting finding is that the empowerment for decision to change job and residence showed negative correlation in the study area. Another important finding was that 82 % of respondents were very dissatisfied with compensation payment in the area. These findings raise intriguing questions regarding the nature and extent of land acquisition and compensation process for sustainable improvement and recovery of expropriated households jobs in the area. The present study showed that demolition of property by court decision is negatively correlated with the expropriated households’ consent to change job in the area.

Enjoying clean environment, disappearance of cultural intact and demolition of property of expropriated households by court decision are increasing in the area are factors that significantly affect the consent of expropriated household to change job. Level of education, empowered for decision, present complain to court, and entitled land for house construction are additional factors affecting the probability of consent of expropriated households to change job in Sabata town.

Generally more than half of the expropriated households were not satisfied with the compensation payment made on property valued by state fixed price. According to key informant and focus group discussion property valuation for land acquisition for industrial development is arbitrary and did not offer sustainable income generation. Thus, the government should take this into account and devise restoration strategies through the implementation of professional property valuation; pre planned expropriation; calculation of compensation payment taking into account the different variables (inflation, area specific prices, intangible asset, life expectancy, lease period, old aged, children and disability); awareness creation; pre prepared residential house constructed, provision of share of holding for expropriated households from company, participatory and accountable valuation; initiation of property valuation institution, and creation of safe environment for the society.

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Paper II The Impacts of Industrialization on Welfare of Expropriated Households

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Abstract

In Ethiopia like in many developing countries the government controls the land acquisition for expansion of industries through expropriation of farmland or urban land. In this study mixed research methods (qualitative and quantitative) were used to compare the impacts of expropriation using the non-expropriated households as control to systematically analyze the impacts of land expropriation on the welfare of the expropriated households in Sabata town, central Ethiopia. The mixed research methods were used for data collection. The data was analyzed using descriptive statistics and econometric models of endogenous switching regression to explain the impacts of expansion of industry on welfare of the expropriated households. The study results showed that the expropriated households have lower total income and higher personal expenditures than the non-expropriated households. Similarly the majority of the expropriated households are categorized under poor wealth status whereas significant proportions of the non-expropriated households are categorized as middle wealth group. The total income of the expropriated households was significantly lower than that of the non-expropriated households. The average land holding among the expropriated households was lower than that of the non-expropriated ones. Wage based employment was the main means of livelihood for the expropriated households as opposed to the non-expropriated ones, for whom own farming was the main means. Thus, there should be a restoration mechanisms through the implementation of livelihood improvement fund; provision of share stock from company; promotion of small business, entrepreneurship development and technology incubation cluster center; provision of finance for startup business without interest rate, training of expropriated people at grassroots level regardaing financial accounting and management system, provision of infrastructure and service facilities, and creation of safe environment for the society.

Keywords: Acquisition, Ethiopia, Expropriation, Sabata, Welfare

Introduction

In developing countries, the share of value-added goods from manufacturing industries increased two fold between 1992 (18 %) and 2012 (35 %) due to shifting from dependence on agriculture and local natural resource extraction to industrial led development (UNIDO, 2014). The expansion of manufacturing industries has been responsible for expropriations of households with the resultant negative effect on the welfare of evicted households worldwide. Studies showed that expropriation is staggering worldwide although exact statistics on development induced expropriation is lacking (Parasuraman, 1999). The existence of expropriation was well documented in western countries along with the presence of strong legal systems and effective grievance handling procedures for entitlement of expropriated households (Parasuraman, 1999). Scholars, journalists and human rights activists claimed that internally expropriated persons (IDPs) or development-induced expropriation ensued due to big companies and growth of infrastructures (Feldman & Geisler, 2012). This expropriation resulted in loss of land, which was underestimated and restrained by the consideration of collateral issues of modernization by development institutions.

In general land acquisition for industrialization reduced households' food security, their access to land, increased cost of land, and change in farming systems (Hamenoo, 2014). Thus, the vindication of industrialization in poverty reduction made many scholars asked question "can such development be regarded as sustainable development?" (Parasuraman, 1999). So, scholars argue that the coping strategy to avert risk has to be in place for attaining welfare strategy for rural families through off-farm, non-farm and on-farm activities (Ellis, 2000). This is aggravated by the fact that two-thirds of the world's poorest people directly depend on land for their welfare

(Felipe, 2005). The situation in Sub-Sharan Africa is not different from this global scenario (Siddiqui, 2012; ACHPR and IWGIA, 2017).

In Ethiopia, expropriation by development projects become among the key challenges to good governance. Together with natural disaster-induced displacement (NDID), man-made-disaster-induced displacement (MDID), conflict-induced displacement (CID) and pastoralism related displacement, it has been causing violations of the physical security, welfare, access to land, health, education, and other rights (Mehari, 2017). It had legal backing in which the Ethiopian Investment Commission has been promoting and facilitating development of manufacturing industries (Proclamation No.769/2012).

Studies conducted on displaced farmers in Mekele town showed that they have lost their welfare, being deprived and became destitute (Zemenfes et al., 2014). This was aggravated by the reluctance of the investing bodies to support the displaced farmers as shown in Kombolcha town of Ethiopia (Muluwork, 2014) and absence of uniform rehabilitative schemes in the country (Muradu, 2015).

In addition, studies revealed that there is increasing number of actors taking part in the commercialization of land formally or informally, transformation of land use and ways of welfare as result of urbanization. These actors escalate land dispossession from residents and endangered farmer's adaptive strategies of individual orientation in the mildest of competing perception resulting in resistance and struggle between the indigenous and the newcomers as shown in Laga Tafo Laga Dadi town (Teshome, 2014). It has also been evident the study that there was absence of adaptive strategies from the government side for dispossessed farmers and the analysis did not include farmers who totally lost land (displaced).However,unsustainable appropriations of agricultural land for industrialization accompanied with municipal land uses in Gelan-Dukem industry area resulted in a significant and considerable negative socioeconomic impacts on smallholder farmers (Dadi, 2016). The previous studies, however, focused only on dispossessed farmers but did not include non-expropriated households and urban residents. They did not also analyze the welfare of the expropriated households using the social framework into projects (Smyth and Vanclay, 2017) and Households Economy Analysis Framework (HEA) (Tanya Boudreau of the Food Economy Group, 2018)

In Ethiopia, one of the most populous towns where manufacturing industries are steadily growing is Sabata. The growth of manufacturing industries in Sabata town might have both positive and detrimental impacts on the welfare of the expropriated households. The purpose of this study, therefore, was to investigate the impacts of expansion of manufacturing industries on the welfare of the expropriated households in Sabata town and its outskirt. The results can be used to devise strategic policy to avert the adverse impacts of expansion of manufacturing industries on the expropriated household's welfare. In addition, to its effect on welfare of expropriated households, the expansion of manufacturing industries is taught to cause paradigm shift in economic activities and cultural assets.The core theme of this work is to analyze the impact of expansion of manufacturing industries on the welfare of the expropriated households. The study targeted the expropriated, non-expropriated and urban residents. The main objective of the study was to examine the impacts of the expansion of manufacturing industries on the welfare of the expropriated households in Sabata town of Oromia National Regional State; Ethiopia.The specific objectives were to analyze the impacts of industries-induced expropriation on the welfares of the expropriated households.

Methods of the study

Description of Study area

Sabata town is one the major towns under Oromia Special Zone Surrounding Finfinne (OSZSF) and is the third-largest urban land size next to Dukem and Burrayu. Masresha (2013) estimated the rate of urbanization in OSZSF to be ranging from 6 to 10 %, which is very high from both national and international perspectives (Dajene, 2018). The proportion of land engulfed by the urbanization and industrialization was estimated to be 3.7 % per year. This may be due to the expansion of industrial and increased investments activities in the study area.

Regarding the magnitude of the manufacturing industries in Ethiopia, more than 40 % of them are situated in Addis Ababa followed by Oromia accounting for 21 % (CSA, 2011). Among the manufacturing industries in the area, more than 26 % , 22 %, and 13 % are food and beverage industries, nonmetallic mineral products, and furniture industries, respectively (CSA, 2011). The number of households engaged in manufacturing industries was over 186,000 during 2009/10, of which 32 % ,11 %, and 11 % were engaged in food products and beverage factory, textile factory, and non-metallic plants in 2009/10, resppectively (CSA, 2011).The total number of investment projects approved in ONRS from 1992-2014 was 9,662, of which about 5,040 (52.16 %) agriculture and 4,622 (47.83 %) manufacturing industries and service projects (OIC 2014).

Concerning performance status, the manufacturing industries in ONRS showed that 4281 (44 %) operational, 3132 (32 %) under construction, 1489 (15 %) not implemented, and 763 (8 %) construction completed, abandoned and at the preliminary phase (OIC, 2014). Unavailability of infrastructure/utility, deleyed land handover and mismanagement are the main reason for most manufacturing industries delayance of producing goods and services in the area (OIC, 2014).

Table 2.1The number and types of operational manufacturing industries in Sabata town (1992-2019)

Types of industries	Number	Land sizes (hectare)	Planned capital (ETB'000)	Actual capital (ETB'000)	Actual job opportunity			
					Permanent Male	Permanent Female	Temporary Male	Temporary Female
Plastic	47	28.8413	26200	27900	43	38	23	22
Construction	28	20.4092	2948397	663040	584	422	4063	1768
Textile	18	28.8900	253100	3432500	9686	4251	158	155
Furniture	11	17.5906	69398	193500	517	440	457	446
Metal	10	21.0919	3022088	2994450	156	146	70	120
Food	9	5.1718	34689	77700	452	361	76	67
Chemical	5	1.7820	23000	38100	108	134	90	52
Tannery	4	3.2366	23600	156000	550	297	28	30
Paper	4	1.9775	23200	25000	88	80	26	25
Beverage	2	1.8001	19000	18400	62	80	41	45
Total	138	130.79	6441000	7601000	12246	6249	5032	2730

Source: Computed data acquired from OIC, November 13, 2019

Regarding the job opportunities, the manufacturing industries created permanent job opportunities for 12,246 men and 6,249 women from 1992 to 2019. Furthermore, manufacturing industries in Sabata town provided temporary employment for 5,032 men and 2,730 women (analyzed from OIC database, 2019).This revealed the occurrence of gender-disaggregated effects of occupational safety and health issues in the area.

Table 2.2 The total manufacturing industries in Sabata town by Kebeles (1991 to 2019)

Kebeles	Year	No.	Area (ha)	Capital (ETB Million)	Job by sex	
					M	F
Furi	1992-2013	64	55.14	2379	3219	2242
Karabu	2003-2015	34	3.1	3543	5199	6606
Dalati	1991-2013	9	44	1056.9	618	2082
Roge	2008-2015	8	8.22	341	265	181
Dima	2003-2013	8	27.9	1036.4	567	1603
Sabata	2007-2014	6	57.5	812	604	309
Alamgena	2006-2013	6	5.54	837	619	192
Walate	2003-2013	3	3.3	224	56	44
Total		138	254.7	10229.3	11147	13259

Methods of the study

Survey methods were applied for data collection. This study utilized a post hoc research design. All expropriated households were traced to their present place of habitation, and their condition was assessed. The practice of land acquisition, compensation, and expropriation by industrial development was assessed by analyzing post displacement conditions in the area. For the expropriation, a comprehensive socio-economic and demographic situation assessment was carried out for post displacement for all households' welfare.

This study employed the mixed methods of qualitative and quantitative approaches. A household survey was conducted on 205 and 244 expropriated and non expropriprated households sampled through strata sampling techniques. Furthermore, the primary data was collected through a survey questionnaire, key informant interview, focus group discussion, and field observations while the secondary data was acquired from different written and documented sources. Additionally, a desk review was employed.

Focus group discussion and key informant interview

Household surveys generated quantitative data on the impact of displacement and resettlement on economic and social conditions. However, the surveys were designed to provide a full assessment of expropriated households' welfare. Furthermore, the household surveys, in all manufacturing industry projects qualitative data were collected from various focus groups and key informant interviews.

The focus group discussions were conducted after the official records and household surveys had been analyzed. Analysis of official documents and discussions with officials provided an understanding of the means of acquiring expropriated households welfare from the government's viewpoint.

Sample Size

For sample size estimation, it was crucial to identify attributes such as the number of expropriated households of the study area. The total number of expropriated households was about 3,665 (of which 1000 expropriated households by operational manufacturing industries) during the years 1992 to 2017/18 (Central Oromia Displaced Community Development Affair Agency, 2018). Based on this baseline data, this study was used a Kothari (2004) formula to determine sample size. Thus, 240 expropriated households affected by the industries were selected. Finally, this study collected survey data from a total of 240 households, of which 205 were responded by expropriated households. The response rate was 84.4 %. The rest 14.6 % was the incomplete response and rejected responses. This study was also deployed data collection five participants selected of 10 and 19 groups of FGD and KII making a total of 29 groups (145 individuals) for qualitative analysis.

Data analysis

The survey data were analyzed by using descriptive and inferential statistics and Endogenous Switching Regression model for quantitative data and concurrent triangulation method for qualitative data to capture the impacts of industry on the welfare of expropriated households.

At each stage of discussions, the secondary information obtained from different sources was added to make the survey analysis to be inclusive. On the other hand, qualitative data from KII and FGD were transcribed, categorized, enumerated, looked for relationships, and interpreted. The qualitative data via KII and FGD will be qualitatively analyzed and integrated to support the survey results for triangulation purposes as suggested by Guba and Lincoln (1985).

The endogenous switching regression with help of Stata version 14 was employed to test the significance of variables and analysis of the impact of industries expropriated household total income and personal expenditure (Lokshin, M. and Sajaia, Z. ,2004). The analyzed data were summarized and presented by using different kinds of illustrations, statistical tables, graphs, and charts.

Variable definition for expropriated welfare

The quantitative data was collected based on sampling procedures that incorporate the lists of industries, expropriated and not expropriated households and gender disaggregated employees was clustered to respondent as expropriated households, and not expropriated households for primary data collection. Households Economy Analysis Framework (HEA) is an exclusive welfare-based analytical framework used for households' economies at diverse stages of a wealth range and economic behavior where in community is already engaged (Tanya Boudreau of the Food Economy Group, 2018). Grounded on this, the indicators of Social Framework into Projects were used to analyze the expropriated households' welfare (Smyth and Vanclay, 2017). The descriptive analysis was used to analyze expropriated households welfare using Social framework into projects variables (assigned as the independent variables) by expansion of manufacturing industry a two variables (specified as the dependent variable) on annual income and consumption expenditure (Owusu, et al., 2011; Zax, 1997; Kassie *et al.*, 2008). According to Deaton (1977) income is understated and intricate to retain information and therefore, consumption spending is also used as indirect indicator of income of household welfare in developing countries. Furthermore, this study was employed non-expropriated households as a control group and expropriated households as treated group. Therefore, the definition of variables under the study was given below in Table 2.3.

The dependent variables considered in this study include the income and consumption expenditure of households (Bahabelon, 2019).While, the outcome variables include land; households capabilities, social support; cultural attributes; welfare issues; shelter and commercial structures; and the living habitat (Smyth and Vanclay, 2017).

It is the amount of income earned and expense for consumption used to measure the household welfare (Lipton, 2009). It considers total households income from different origins such as income from farm and nonfarm activities, as the expropriated and non-expropriated households is managing different activities to sustain their households' expenditure and run into other social responsibilities (Bahabelon, 2019). Moreover, there are expenses to be incurred in the process of generating income and expenses for consumption to the households that affect earnings.

Table 2.3 Variable definition and working hypothesis

Variable	Description	Measurement	Expected effect
Dependent variable			
Total income	Total income per capita	Continuous (ETB)	+/-
Total expense	Total Personal Expenditure	Continuous (ETB)	+/-
Independent variable			
SHHHead	Sex of households head	Dummy	+/-
AHHyear	Age of households head in year	Continuous (Year)	+/-
MMSHH	Marital status of households head	Categorical (Type)	+/-
TFSHH	Number of family/households size	Continuous (Number)	+/-
EDUNO	Education level	Continuous (Number)	+/-
NDEPNO	Number of dependent members	Continuous (Number)	+/-
LEDUCOMP	Year of education completed	continious (number)	+/-
TLU	Troppical Livestock unit	Continious(Number)	+/-
EXP HH	Expense for social services	Categorical (type)	+/-
EXPHC	Expense for house construction in birr	Continuous (ETB)	+/-
EXPPT	Expense for personal transport in birr	Continuous (ETB)	+/-
IIWM1	Own waste management system	Dummy	+/-

Endogenous Switching Regression Model

Model Specification

The impact assessment studies based on cross-sectional data used endogenous switching regression model (Alene and Manyong, 2007; Mulubrhan et al., 2012; Solomon et al., 2012; Menale et al., 2014; Abdulai and Huffman, 2014; Moti et al., 2015). The switching regression models of total income and household's per capita expenditure intuitively involves separate estimations for expropriated and non-expropriated families due to the possible systematic differences in mode of access to an improving sustainable welfare strategy. Accessibility to sustainable improved welfare strategy of expropriated households thus becomes the selection criterion governing observation or otherwise of total income and consumption expenditure. The equation described Foltz (2004) was used in this analysis. Letting Ii represent an expropriated households access to improved welfare dummy where $i \in [0, 1]$, a welfare selection criterion function can be expressed as

$$Ii = \gamma' Zi + ui \qquad (1)$$

u_i~(0, 1). Where, Z_i is a vector of households, socio-demographic characteristics, as well as instruments deemed to influence expropriated households acquired improved welfare of households i, γ is the vector of parameters to be estimated, and u_i is the error term . Also let Y_i represent the level of total income and consumption expenditure. Based on the access to improved welfare selection criterion function of equation (4), outcomes (Y_i) are observed for two different regimes (see Maddala, 1983; Gebregziabher, 2008).

$Y_{1i}=\beta_1'X_{1i}+\nu_{1i}$ if and only if $\gamma'Z_i+u_i>0$: expropriated ($I_i= 1$) (2)

$Y_{2i}=\beta_2'X_{2i}+\nu_{2i}$ if and only if $\gamma'Z_i+u_i\leq 0$: Non-expropriated ($I_i= 0$) (3)

where, X_i is a vector of exogenously determined variables of households i, β is the coefficient vector, and ν, the residuals. Following Foltz (2004), we first assume that the unobserved residual effects on total income and consumption expenditure between expropriated and non-expropriated are independent of the unobserved effects on access to sustainable improved welfare condition. That is $E(\nu_{1i}|I_i=1)=E(\nu_{2i}|I_i=0)=0$, and $Cov(u_i\nu_i)= 0$

This implies that sample partitioning between expropriated and non-expropriated is entirely exogenous to their behavior so that an exogenous switching structure results, as in equations (2) and (3). The unconditional expectation of these models can be expressed as

$E(Y_{1i}|x_{1i})=\beta_1'X_{1i}$ (4)

$E(Y_{2i}|x_{2i})=\beta_2'X_{2i}$ (5)

Applying least squares to equations (4) and (5) gives consistent estimate of the β.

However, there is a high likelihood that uncontrolled factors (e.g. household source of income managing capacity) in the disturbance term, u_i, influencing access to improve their welfare also simultaneously influences the level of outcomes (e.g. total income and consumption expenditure), so that cov $(uivi) \neq 0$. Under this scenario sample separation between expropriated and non-expropriated become endogenous to their behavior and governed by an access to improve welfare regime. Here the expected values of the error terms in the outcome equations conditioned on the sample selection is non-zero and least squares renders estimated coefficients inconsistent and inefficient (Freeman *et al*. 1998). Here, the error terms $v1i$, $v2i$ and ui are assumed to follow a trivariate normal distribution with mean vector zero and covariance matrix (Maddala, 1983; Lokshin and Sajaia, 2004)

$\Sigma = \sigma u2\sigma 1u\sigma 2u\sigma 1u\sigma 12\cdot\sigma 2u\cdot\ \sigma 22$

where, $\sigma u2$ is the variance of the error term in the selection equation, $\sigma 12$and $\sigma 22$ are the variances of the error terms in the continuous equations; $\sigma 1u$ is the covariance of ui and $v1i$; and $\sigma 2u$ is the covariance of ui and $v2i$. As can be deciphered, the covariance between $v1i$ and $v2i$I s not defined as $Y1i$ and $Y2i$ are never observed simultaneously. It is assumed that $\sigma u2$= 1, since γ is estimable only up to a scalar factor (Maddala, 1983). The expected (conditional) outcomes of total income and consumption expenditure for the two regimes are expressed as

$$\mathrm{E}\ Y1iI = 1 = \beta 1'X1i + \sigma 1\rho 1\ W\ 1i \qquad (6)$$

$$\mathrm{E}\ Y2iI = 0 = \beta 2'X2i - \sigma 2\rho 2\ W\ 2i \qquad (7)$$

where $\sigma 1$ and $\sigma 2$ are the standard deviations of the two outcome equations, respectively; $\rho 1$is the correlation coefficient between $v1i$and ui; $\rho 2$ is the correlation coefficient between $v2i$ and ui. W $1i$ and $W\ 2i$ are the non-selection hazard terms for the respective regimes. The model in (6) and (7) are identified by construction through nonlinearities. The models can be fitted one equation at a time by either two-stage least squares or maximum likelihood estimation. However, both estimation methods are inefficient and require potentially cumbersome adjustments to derive consistent standard errors (Lokshin and Sajaia, 2004).To obtain consistent standard errors; the full information maximum likelihood (FIML) method was employed to simultaneously fit the binary and continuous parts of the model. This approach relies on joint normality of the error terms in the binary and continuous equations.

The non-selection hazard term otherwise known as the inverse Mills ratio is the ratio of the probability density function to the cumulative distribution function (cdf) of a standard normal evaluated at $\gamma' Zi$. Given the assumption with respect to the distribution of the disturbance terms, the logarithmic likelihood function for the system of equations in (6) and (7) is InL =($iIi\omega iIn\ F\ \eta 1i$+ $Inf\nu 1i\sigma 1\sigma 1$+ $1 - Ii\omega i$[$In\ 1 - F\ \eta 2i$+ $Inf\nu 2i\sigma 2\sigma 2$])

$$InL = \sum_i (I_i \omega_i \left[In\{F(\eta_{1i})\} + In \left\{ \frac{f\left(\frac{\nu_{1i}}{\sigma_1}\right)}{\sigma_1} \right\} \right] + (1 - I_i)\omega_i [In\{1 - F(\eta_{2i})\} + In \left\{ \frac{f\left(\frac{\nu_{2i}}{\sigma_2}\right)}{\sigma_2} \right\}])$$

where F (·) is a cumulative normal distribution function, f(·) is a normal density distribution function, ωi is an optional weight for observation i, and $\eta_{ji} = \frac{(\gamma Z_i + \rho_j \nu_{ji} / \sigma_j)}{\sqrt{1-\rho_j^2}}$; j = 1, 2; where, $\rho 1$= $\sigma 1u2/\sigma u\sigma 1$ and $\rho 2$=$\sigma 2u2/\sigma u\sigma 2$.

Results

Socio-demographic characteristics

The expropriated and non-expropriated households accounted for 45 % and 55 %, respectively. The gender of household heads showed that about 75 % were male and 25 % were female (Table 2.4). The education level of households heads showed that 44 % had primary level of education, 17 % had secondary level of education (grade 9-12), and 15 % were illiterate. The number of households' expropriation gently decreases with an increase in educational level. Among the respondents, the proportion having land size ranging from 0 to 0.5 m^2 accounted for 85 %. About 2.5 % of the respondents had land size above 2.01 hectares. Textile and garment industries account for largest land acquisition in the area. Regarding administrative units, Sabata and Walate accounted for 26 % and 22 %, respectively. Local and investors from abroad accounted for 74 % and 16 %, respectively of the land acquired for industry. The legal form of business such as private limited company and sole proprietorship accounted for 84 % and 14 %, respectively. The respondents interviewed revealed that factories release industrial wastewater directly to adjacent rivers and terrestrial earth. Regarding the family size the respondents had 2 (31 %), 3 (14%), and 4 (13%) female family members and 1 (23 %), 2 (29 %), and 3 (23%) male members per household with average number of family of 5 in the area (Annex 2)

Table 2.4 Socio-demographic characteristics of the respondents

Variables	**Frequency**	**%**	**variables**	**Frequency**	**%**
Group			**Type industry owner**		
Non-expropriated HH	245	54.6	Individual	8	3.59
Expropriated HH	204	45.4	Foreign	34	15.25
Administrative unit			Domestic	173	77.58
Sabata	116	25.8	Joint venture	8	3.59
Walate	99	22.0	**Legal form business**		
Furi	84	8.7	Private Limited Company	180	80.72
Alemgena	66	4.7	Sole proprietorship	38	17.04
Dima	42	9.4	Partnership	1	0.45
Daleti	19	4.2	Share Company	2	0.90
Roge	14	3.1	Cooperative	2	0.90
Karabu	9	2.0	**Land size in hectare**		
Sex of households head			0-0.5	378	85.3
Male	339	75.5	0.51-1	28	6.24
Female	110	24.5	1.01-1.5	18	4.01
Marital status of households head			1.51-2	8	1.78
Married	407	90.6	Above 2.01	11	2.45
Widow	23	5.1	**Manufacturing industry Group**		
Single	16	3.6	Brewery, alcohol, and liquor	38	17.04
Divorced	1	0.2	Leather and leather products	1	0.45
Separated	2	0.4	Textile and garment	44	19.73
Religion of the households head			Metal & metal products	18	8.07
Orthodox Christian	298	66.4	Food & beverage	45	20.18
Protestant Christian	85	8.9	Paper & paper Products	11	4.93
Muslim	46	0.2	Construction industry	24	10.76
Waqefana	20	4.5	others	33	18.84
Highest level of education completed by households head					
Primary school (1-6)	197	43.9	Junior secondary (7- 8)	30	6.7
High School (9 -12)	77	17.1	Diploma	24	5.3
illiterate	68	5.1	Formal and read and write	18	4.0
University	35	7.8			

The non-expropriated respondents accounted for 13 % landholding size of 0.5 ha, while 10 % for land size of 0.02 ha as shown in annex 2.1. Non-expropriated and expropriated households owned about 39 and 41 % of land size ranging between 0.01-0.5 ha. Eighty percent of the respondents are very poor. Among the expropriated households 3 % of them were landless. The expropriated households owned a land size of 0.51-1 (1.1 %) and 1.51-2 ha (0.45 %), respectively. None of the expropriated households owned a land size of 2.01 ha or higher. The non-expropriated households accounted for 3.8 % of those who owned a land size of 2.01 ha and above in the area.

Regarding the gender distribution, 41 % of male and 14 % of constitute non-expropriated households (Annex 2.2). The expropriated households comprise 35 % male and 11 % female respondents.

The vast majority (91 %) of the households were married. About 3.3 % and 0.22 % of the non-expropriated and expropriated households respectively were unmarried whereas 2 % and 3.1 % of the non-expropriated and expropriated households respectively were widows. Among the participants Christians account for 73.3 % while Muslims account for 26.7 % (Annex 2.3). Of the total of the respondents, those who were living in the area for 16-25 years and above 25 years accounted for 18 % and 66 % of the non-expropriated households. For the expropriated households who residing in the area for 16-25 years and above 25 years accounted for 40 % and 41 %, respectively. Annex 2.4 provides the distribution of the number years of residence of the participants in the area.

Economic Activities

For the expropriated households daily labor and wage based employment was their first main means of welfare (47 %) followed by owning replacement farming, which was mainly livestock production (15 %) and trading (12 %) (Annex 2.5). For the non-expropriated households the main means of welfare was own farming (31 %) followed by trading.

Ownership of assets

Productive asset was the main welfare activity for both expropriated and non-expropriated households in the area (Annex 2.6). The expropriated households that were poor accounted for 91 % whereas 76 % of the non-expropriated households were categorized under middle wealth status. The welfare activities of prime importance was own farming followed by trading as main source asset acquisition for non-expropriated households. Average hens own accounted about poor wealth status of 87 % for expropriated and middle wealth status of 42 % for non-expropriated households. Average donkeys own accounted about poor wealth status of 86 % for expropriated and middle wealth status of 98 % for non-expropriated households. Average goats own accounted about poor wealth status of 82 % for expropriated and middle wealth status of 71 % for non-expropriated households. However, the better off wealth group was not prevailed in both expropriated and non-expropriated households of the respondents. Generally, the wealth status was in poor and middle group for the expropriated and non-expropriated households, respectively.

Sources of income generation

The annual income generation by small business or share cropping accounted is the main ones for 99 % of middle wealth group among non-expropriated households and 98 % poor wealth group in expropriated households (Annex 2.7). Income generation from small ruminant production accounted for 98.5 % of poor wealth group in expropriated household's, whereas non-expropriated households the annual income generation incurred from the sale of hens and eggs accounted for 94 % of the poor wealth group and group 98 % of the non-expropriated households. Dairy production through sale of milk and milk products also account for generation of income for significant proportion of both non-expropriated and expropriated households.

The percentage distribution of monthly income in Ethiopian currency (ETB) of the expropriated and non-expropriated households is given in Table 2.5. Among the non-expropriated households those who earn more than 4000 ETB per month made 43 % whereas for the expropriated households only 14 % earn more than 4000 ETB. Forty-nine percent of the expropriated households had monthly income of ETB 1600 suggesting that most of the expropriated households are classified as poor. Taking nominal income value of USD 1.90 (equals to 1170 birr per month) of the monthly income revealed that 72.4% expropriated households fail under income poverty line. Using expense as an indirect measure of income and USD 1.90 (PPP per day) makes expropriated households go amiss in the menace of income paucity. Among the expropriated households who did not have any income was 3.4 %.

Table 2.5 Monthly income (ETB) category of households head by wealth category

Monthly income (ETB)	Wealth Category	Non-Expropriated		Expropriated	
		No	%	No	%
0	0	0	0	7	3.4
Less than 1600	Very poor	5	2	101	49
1601-2000	poor	40	16	41	20
2001-3000	poor	52	21	14	5.6
3001-4000	middle	41	16.7	13	5.2
Above >4001	Better off	106	43.3	29	14

N.B. The wealth status was based on Becho-Adea teff and chickpea Welfare Zone 2017

Access to infrastructure/ social services

The average distance from health centers was about 1000 meter for 73 % and 77 % of the non-expropriated and expropriated households, respectively (Annex 2.8). Twenty-one percent of the expropriated households travel about 2 km to get health services while the maximum is 1 km for the non-expropriated ones. The average distance from portable water was 1000 meter for 69.4 % of the expropriated but expropriated ones had better access to water. Expropriated households travel longer distance to market centers than their non-expropriated counterparts.

Livestock and crop production

Milk production accounted for 81 % and 85 % of the non- expropriated and expropriated households, respectively (Annex 2.9). Cereal crop production accounted for 61 % and 88 % of the non-expropriated and expropriated households, respectively. Pulse production accounted for 60 % and 93 % of the non-expropriated and expropriated households, respectively.

Impact of industry on expropriated households income

The predicted total incomes for expropriated and non-expropriated households are summarized in Table 2.6. T-test between the two groups showed the non-expropriated households possess significantly higher total income (ETB 212,416) than the expropriated counterparts (ETB 34,018) (Table 2.6). The real income status decrease significantly for expropriated household than non expropriated households. The household income of non-expropriated was significantly higher than the total income of expropriated households.

Table 2.6 Results of prediction of total income with ESR

Two-sample t test with equal variances						
Group	Obs	Mean	Std.err	Std.Dev	[95% Conf. Interval]	
Non-Expropriated	244	212416.1	1336.715	20922.9	209783.1	215049.1
Expropriated	205	34018.63	3981.986	56874.14	26167.27	41869.98
Combined	449	131362.5	4626.789	98039.9	122269.6	140455.4
Heterogeneity difference		178397.5	3917.08	-	170699.3	186095.7
Diff mean (nonexp) - mean(exp)					t = 45.5435	
Ho: diff = 0					Pr (T > t) = 0.0000	
Ha: diff = 0					Pr (|T| > |t|) = 0.0000	
Ha: diff < 0					Ha: diff > 0	

Likelihood ratio test of independence of the regime and outcome equations is also significant at the 5 % level in Table 2.7. The TLU, firm owners waste management system, and number of educated in the household also negatively significant variation in total income in the area. On other hand, the age of households head was positively affected in the households' welfare of expropriated households. Moreover, the age of households head, and TLU were significantly affected the expropriated households welfare.

Table 2.7 Full Information Maximum Likelihood Estimates of the SRM.

Dependent variable: Total income

Explanatory Variables	**FIML Endogenous Switching Regression**					
	Selection equation(Expropriated)		Expropriated-1 (Expropriated)		Non expropriated-0 (Non-Expropriated)	
	Coefficient	Z -value	Coefficient	Z -value	Coefficient	Z -value
Sex of households head	.6582734	1.18	-8746.088	-0.99	2250.728	0.42
Age of households head in year	.0446643***	3.04	487.4493	1.51	-212.5437	-1.75
Education levels of HH head	.3719555*	2.17	-7371.774	-1.76	-2062.998	-1.03
Number of dependent member	-.3165567	-1.80	3819.713	0.76	1927.931	1.69
Number of years education completed	-.0603692***	-3.97	-106.3936	-0.26	105.7483	1.16
Tropical Livestock Unit	-.0521453***	-4.35	149.6756	0.53	242.3469	1.61
Integrated industrial waste management system	.0572037	0.08	-155039.1 ***	-4.15	16746.15	1.07
_cons	.4020763	0.28	325612.8 ***	4.29	189534***	6.20

NB.***, ** and * are significant at 1%, 5% and 10% level.

Impact of industry on expropriated households personal expenditure

The predicted expenditure for expropriated households possess significantly higher expenditure (ETB 18507.6) than the non-expropriated households (ETB 13947.9).There was a substantial increase of spending after expropriation than non expropriation (Table 2.8).The burden of spending for expropriated households was also increased considerably. This indicates that the expropriated households affected negatively expropriated households than non expropriation households in the area.

Table 2.8 Test of predicted consumption expenditure

Two-sample t test with equal variances						
Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Non-expropriated	244	13947.96	57.24069	895.9585	13835.21	14060.71
Expropriated	205	18507.6	794.4733	11347.35	16941.12	20074.08
combined	449	16019.6	377.391	7996.773	15277.92	16761.28
Heterogeneity difference		-4559.639	727.503		-5989.39	-3129.888
diff = mean (0) -mean (1)				t = -6.2675		
Ho: diff = 0				degrees of freedom=447		
Ha: diff < 0				Pr(T < t) = 0.0000		
Ha: diff != 0				Pr (|T| > |t|) = 0.0000		
Ha: diff > 0				Pr(T > t) = 1.0000		

Likelihood ratio test of independence of the regime and outcome equations is also significant at the 5 % level in Table 2.9. The variables expense for house construction, expense for social events, expense for personal transport services used, and Tropical Livestock Unit were significantly explain for the variation in personal expenditure per-capita in Birr per month for expropriated household welfare. The age of household’s head and marital status of household’s head were significantly affected the welfare of non-expropriated households. In both the non expropriated and expropriated households’ welfare, the variables expense for social events, house construction, and transport services were made significant variation in personal expenditure per capita in the area.

Table 2.9 FIML Estimates of the Switching Regression Model

Explanatory variables	Full Information Maximum Likelihood (FIML) Endogenous Switching Regression					
	Selection equation (Expropriated)		Expropriated-1 (Expropriated)		Non expropriated-0 (Non-Expropriated)	
	Coeff.	Z -value	Coeff.	Z -value	Coeff.	Z -value
Sex of household Head	.3358254	0.42	1698.156	1.62	-1.13e-10***	-5.18
Average age household head in year	.0682894	2.56	-81.21603	-1.52	2.37e-12 ***	2.84
Marital status of HH head	.6775583	1.00	-132.946	-0.21	-5.55e-11***	-4.24
Year of education completed	-.0967146***	-3.13	75.19833	1.52	-2.96e-13	-0.52
Number of educated in household	-.2469329	-0.62	-504.7326	-1.31	3.68e-11***	4.22
Number of dependent members	-.8749937	-1.95	672.3854	1.37	-1.12e-11	-1.55
Tropical Livestock Unit	-.0775677***	-3.91	29.06947	0.68	-7.97e-12	-3.51
Expense for social events	-.0028842 ***	-4.37	1.709892 *	2.01	2.900855***	5.9e+12
Expense for house construction in birr	0019267***	4.29	1.149563***	13.74	5.124786***	6.7e+12
Expense for personal transport services	-.0779475***	-3.10	-8.48846*	-1.89	-17.71795***	-7.7e+12
_cons	9.528881***	2.81	15280.34 ***	3.86	2396.581***	1.2e+12

NB. ***, ** and * are significant at 1%, 5% and 10% level.

Impact estimates by Endogenous switching regression model

The estimates for the average treatments effects on the treated (ATT), average treatments effects on the untreated (ATU) and the heterogeneity effect (HE) which show the impact of industries on expropriated households welfare due to their inherent characteristics on households income and expenditure, are presented in Table 2.7 and 2.9. Unlike the mean differences presented in Table 2.6 and 2.8, which may confound the impact of industries on expropriated households' welfare, The ESR estimates of ATT and ATU account for selection bias arising from the fact that total income and expenditure may be systematically different (Table 2.10). The results revealed that non expropriated income significantly increases and decrease expenditure of non-expropriated and also had the potential to increase that of the expenditure and decrease income for expropriated households due to expansion of industries in the area. Generally, the expropriated in Sabata receive 57 % less income than non expropriated households' income, while expropriated households in Sabata personal expenditure was increased by 14.1 % than non expropriated households in Sabata town.

Table 2.10 Expected conditional and average treatment effects

Outcome variables	Households status	prediction		Treatment
		Exp	Non exp	Effect
Total income	ATT	26672.08	34018.63	7346.55
	ATU	97083.12	212330.6	-115247.48
	Heterogeneity effect	70411.04	178311.97	
expenditure	ATT	18507.6	15641.41	2866.19
	ATU	13946.2	9324.675	-4621.525
	Heterogeneity effect	4561.4	6316.735	

Note: (a) and (b) represent observed outcomes (personal consumption and households income status) ; (c) and (d) represent counterfactual outcomes (personal consumption expenditure and households income status) ; Ai=1 if households i expropriated; Ai=0 if households i did not expropriated. Y1i= personal consumption expenditure and households income status if a households expropriated; Y2i= personal consumption expenditure and households income security status if a households did not expropriated; ATT =average treatment effect on treated; ATU=average treatment effect on untreated. BH1=the effect of base heterogeneity for expropriated; BH2=the effect of base heterogeneity for non-expropriated.TH=transitional heterogeneity (ATT-ATU)

Discussion

The expropriated households possess only small land size, the majority (85 %) of them own land ranging from 0 to 0.5 m^2 clearly showing that industrialization is making them landless. This has considerable impacts on the welfare and socioeconomic and cultural assets of the community.So, the expansion of industries in Sabata town made the expropriated household vulnerable to a multitude of social crisis, decreased level of income, landlessness and other risks. Elsewhere in the world similar scenario has been reported in which expropriation culminated in the loss of physical assets such as shelters, social values, farmland, revenues, and others (Downing, 2002).

It is further stressed that expropriation can result in the displacement and improvishment of people, which can ultimately cause huge socio-economic and political crisis (Downing, 2002). Therefore, this study revealed that the government and the company should take into account the welfare of the expropriated communities while taking their land study conducted by Harris (2015) showed that the Ethiopian government's way of intervention of the land acquisition process for industrialization has been impacting the welfare of the landholders of farm and urban land. This study was also supported by the industrialization affected the welfare strategies such as loss of welfare land of expropriated households in Ethiopia (Lenin *et al.*, 2018).

The expropriated households became daily laborers for whom wage from various employments is the main means of welfare. The expropriated households were not accustomed to the wage based employment and they did not have training on such activities earlier. Thus, the sustainability of their improvement of welfare is questionable.They lost their land on which their means of welfare was own farming and trading activities, this might lead them to destitution in the long run. Our findings are in consistent with previous studies that pinpoint the expropriated households start more businesses and participate in non-farm activities than non-expropriated households in

Ethiopia (Harris, 2015). In consent to our observation Harris (2015) revealed that the expropriated households change their way of life from farming to livestock production. Livestock production requires land as so does for the crop farming and it is even more demanding financially than crop production. Hence, the expropriated households need training and sources of funding for sustainable and secure welfare that is based on livestock enterprises. The absence of such compensation system can liable them to poverty.

Since the expropriated households had not been adapted to the new business the annual income generated through the sale of livestock products is not sufficient to sustain their lives. That is, compared to the non-expropriated households they are categorized under poor wealth group. In agreement to this study it has been shown that households who were expropriated from their land for industry purposes elsewhere in Ethiopia receive 11 % less income than before (Harris, 2015). Our observation is also similar to previous studies done in some countries of Africa such as Kenya (Kariuki, 2016) and in other parts of Ethiopia (Muluwork, 2014) and elsewhere in the world (Gerstter et al., 2011).

The comparison of the annual income among expropriated and non-expropriated households supports the above scenario. The expropriated households are on disadvantages in terms of the monthly income suggesting in all parameters the expropriated households are negatively affected by the land acquisition systems intended for industrialization in the area.The findings of this study are consistent with the observations of Harris (2015) who showed that expropriated households derive income from sale of livestock and small business which is quite low. This is partly due to inadequate compensation as observed in Kenya (Kariuki, 2016). In agreement to our observation previous studies showed that land acquisition for the sake of industry has no limits in Ethiopia and it has not been based on the assessment of its effects on socio-economic, cultural and environmental issues (The Oakland Institute, 2011). Elsewhere in the world it has also been reported that low compensation is responsible for low income levels for the expropriated people (Downing, 2002). The low levels income obtained by the expropriated households is further exacerbated by their average distance from services such as portable water, grain mill, and market center. It is corroborated with expropriated households income status worsen and burden of spending after expropriation (Bahabelom, 2019). This further adds costs to the expenditures of the expropriated households making them liable to negative effects on the natural, physical, financial, and social capitals as reported from China (Guo et al., 2019).

The total annual income of expropriated households in the study area are negatively influenced by the number of years of habitation in the area, milk production, pulses and cereal production, gender of households head, sale of egg, sale of goat, sale of oxen, and saving money in the bank. However, positive impacts on annual income was observed for number of educated family member and hired as firm employees. Similar observation was reported in which 65 % of the expropriated households did not have any savings in bank in Ethiopia (Harris, 2015) and elsewhere in the world (Paul and Sarma, 2013; Smyth and Vanclay, 2017).

In addition to low annual income levels, the expropriated households have significantly higher personal expenditure than the non-expropriated households as a result of their distance from social services. This shows that industrialization has multidimensional impacts on the welfare of the expropriated households. This is consistent with the results of Harris (2015) showing the negative impacts of expropriation on the land-lost farmer's health through income and psychological malfunctioning (Wang et al., 2019). The expenses for house construction, social events (rituals, holiday, beverage, alcoholic drinks, and others), transport services, annual purchase of pulses production, TLU, and number of years of residence were all significantly associated with personal expenditures. In first and second stages the expense for buying livestock input and year of residence were made significant variation in personal expenditure per capita. The significant and positive determinants of expropriated households' personal expenditure per capita were age of the households head and expense for households' construction. The significant and negative factor influencing personal expenditure of expropriation are number of year reside in the area, annual food crop production, expense for social events, and personal transport services used in the Sabata town. This study was consistent with expropriated people has faced enormous economic and social problems in the Bahir Dar and Gonder town of Ethiopia (Belachew, 2012).

The results of expected conditional and average treatment effects depicted that non expropriated income significantly increases and decrease expenditure of non-expropriated and also had the potential to increase that of the burden of spending and income status for expropriated households decrease considerably due to expansion of industries in Sabata town. This study was consistent with the total nominal expenditure increased for households that had land expropriated in Ethiopia (Harris, 2015 and Bahabelon, 2019). It is also added the rationale for evicted households increased their consumption due to purchase of food items and relative decreased for the not displaced in Ethiopia (Harris, 2015).

Land expropriation people was not participatory, government promised benefits to the farmers not fulfilled, loss land, lack of knowledge, lack means of compensation paid management, and lack of knowledge and skill to adapt urban ways of life by evicted households in Ethiopia (Eyasu, 2007). Expropriation is plunging innocent victims or expropriated households find themselves "in the way" into new poverty (Downing, 2002, Bahabelon, 2019). Expropriation is frequently characterized by the resulting impoverishment of those displaced, inappropriate property valuation and compensation system for lost assets in Cambodia, China, and India (ADB, 2007). In land expropriation process for industrialization, communities were not consulted or involved communities in most cases; the process of land transfer not disclosed to the local people, company owner and local communities not harmonious, and perceives as their enemies that lead to kept safe by security forces (Lenin et al., 2018). Losing land and receiving compensation increases the value of nonproductive assets held by the households by 5,400 Birr in Ethiopia (Harris, 2015)

Conclusion and recommendation

The results of this study showed that a land acquisition system for industrialization in the area has significantly reduced the land size per expropriated households. This has resulted in the shift of welfare among the expropriated households making them dependent on wages for income generations followed by small farms and trading. This was witnessed by the significantly low levels wealth among the expropriated households, that is, the majority of the expropriated households were categorized under poor wealth category. The shift in economic activities made the expropriated households to mainly depend on the sale of livestock products for accumulation of wealth. Apart from these the expropriated households suffer from lack of social services such as portable water, grain mill, and market centers due to their average distances, which was higher than that of the non-expropriated households.

The monthly and annual incomes of the expropriated households were significantly lower than that of the non-expropriated households. The TLU, annual livestock product production, pulse and food crop production, sales of livestock products, and years of residence in the area were negatively associated with total income of expropriated households. In contrast the numbers of educated family members and hired as firm employees were positively associated with total income of the expropriated people in Sabata town.

Furthermore, the personal expenditures of the expropriated people were mostly accounted for buying livestock inputs and vary according to years of residence in the area. The personal expenditure of the expropriated households was positively affected by expense for household's house construction activities. It was negatively affected by annual food crop production, expense for social events, and personal transport services used in the area. The annual income of the expropriated households was also significantly lower than that of the non-expropriated households. On contrary, the non-expropriated households were increase total income and decrease personal expenditure. In general, the land acquisition for expansion of manufacturing industry has adverse impacts on expropriated household's welfare In conculsion, the government and other stakeholders were advised to improve expropriated farm based rural livelihood through training on strategy to utilize compensated money for acquiring better welfare through investing in productive assets in industry based urban economy. Therefore, the government should take this into account and devise restoration strategies through the implementation of sustainable welfare restoration fund, provision of share stock for expropriated households from company, establishment of small business development, entrepreneurship development and technology incubation cluster center; provision of business startup finance without interest rate, training of grassroots level financial management system, and creation of safe environment for the society.

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Research article

Physicochemical characterization of effluents from industries in Sabata town of Ethiopia

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ABSTRACT

Untreated industrial effluents have often caused environmental pollution and human health concern. This study analyzed the pollution of wastewater from some selected industries in the Sabata town of Ethiopia. The composite sampling techniques were used to collect wastewater from industries in dry (April–May) and wet (June–July) seasons and analyzed physicochemical properties using atomic absorption spectrophotometry. All parameters investigated were analyzed using mean and Analysis of Variance. The results depicted that the conductivity, biological oxygen demand, chemical oxygen demand, and pH were all beyond the safe limits of World Health Organization along the studied Sabata River and industries. This indicates pollution of the water that not apt for drinking, farming, and industrial uses. Furthermore, the electrical conductivity, biological oxygen demand, chemical oxygen demand, total suspended solid, total nitrogen, and total phosphorus were statistically significant ($p < 0.05$), which indicates the disruption of river water quality by industrial effluents. Therefore, the government should take this into account and devise mitigation strategies through enforcing existing standard of industrial pollution control regulation, installation of treatment plant, transforming of industrial residual into biogas products, awareness creation for the society, initiation of sustainable corporate industrial responsibility, and the implementation of environmental protection regulation.

Introduction

Industrial pollution is as old as the civilization that poses a threat to the health and wellbeing of millions of people and the global ecosystem (Priscilla, 1999). With modern civilization, wastes are generated primarily from industries. Specifically, water pollution arising from unprecedented waste disposal of industries in developing countries needs a due concern (Bhuyan & Islam, 2017; Ahmed *et al*., 2019). Industrial wastes were estimated to be 50 % of all the pollutants and contaminated wastes discharged into the environment (Moses, 2014).Thus, environmental pollution wrecks could have an adverse effect on both human being and aquatic biota (Landrigan et al., 2018).

The study carried out by Abdel-Shafy & Mansour (2018) in 4 continents, 22 countries, and 30 urban areas revealed that an immense effect of municipal wastes on the environment. This study also showed that paper (27 %), food (15 %), yard trimming (14 %), plastics (13 %), metals (9 %), rubber, leather and textiles (9 %) and others (3 %) in the United States of municipal wastes contribute to environmental disaster (Abdel-Shafy & Mansour, 2018). This indicates the negative effects of wastes on the environment due to inappropriate waste management system. The industrial wastes had also caused a change in the ecosystem values, pH, conductivity, and trace metals (Priscilla, 1999). Similarly, a consistent economic growth (GDP) rate since 2001 in Sub-Saharan Africa had brought about increasing environmental risks and depletion of ozone layer due to increase in anthropogenic activities (Dodman *et al*., 2013). Therefore, the impact of industrial wastes on environmental resource loss had to be counter balanced with resource gain that can be used by society but not individuals (Enetjärn, *et al.*, 2015).

Recently, the increase of industrial wastes in developing countries is demanding a waste management system. The sustainable development goals highlight the adoption of clean and environmentally sound technologies and industrial processes to get water free from chemical contamination (UN, 2017). In Ethiopia, water free from chemical contamination was estimated to be 13 % (Central Statistical Authority (CSA), 2017). Other studies further state that textile industry in Ethiopia might be a largest source of water contamination due to many textile industries operate without treatment plants and discharge their industrial wastewater directly into river bodies (Sima,S. and Restiani, P. , 2017). Other studies reaffirmed that Akaki River was highly contaminated because of the discharge of the partial treated or untreated industrial industrial wastewater into the river (Abebe, 2019).

Most of the industry promoters in Ethiopia misconceived as costly to prepare and implement EIA (Mellese & Mesfin, 2008). As a result, many factories in the Akaki industrial zone had not appropriately managed their industrial industrial wastewater and disposed their wastes to immediate environment without any precaution (Tesfay, 2014). Previous studies showed that the dust discharged from the industries affect the physiochemical properties of the soils in the area (Samuel and Aynalem , 2012; Assefa and Ayalew, 2014).

Several industries in Sabata town are located close to Sabata River and within residential areas. These industries often discharge either untreated or only partially treated wastes openly into the environment, and affecting the local community health, livestock, wetland, and vegetable farms. The pollution of surface water may result in a high concentration of physicochemical that may disrupt the environment. Some studies were conducted in Ethiopia to explore the concentration level of the physiochemical properties of industrial wastewater from industrial activities. However, there is paucity of information on the spatial and seasonal variation of the physicochemical parameters of industrial wastewater discharged from industries in Sabata. Therefore, this study was aimed to analyze of physicochemical characteristics of industrial wastewater from some selected industries in Sabata town of Ethiopia.

Materials and Methods

Description of the study area

The study was carried out in Sabata town, which is about 24 km distance in the Southwest part of Addis Ababa city. It is located between $8^0$53’39” N to $8^0$59’58’’ N latitude and $38^0$35’12’’ E to $38^0$39’34’’ E longitude. The altitude of the town ranges from 2,060 to 2,670 meters above sea level. Agro-climatically, the town has a temperate climatic condition with a temperature ranging from 12.7 ^{0}C to 24.4 ^{0}C. The total land size of the town was 2.1 Km^2 (1994), 7.41 Km^2 (2011), 9.9 km^2 (BoFEDO, 2014/15) and 17.5 Km^2 (OUPI, 2019). This indicates an increasing trend of the urban land size used for industry development and other development activities. According to the information acquired from Sabata Investment Office, operational manufacturing industries were allocated a land size of 145.85 hectares in the town.

Study Design

The design of this study followed WHO drinking water guidelines (WHO, 2006) and American Public Health Association (APHA) guidelines (APHA, 1999). Accordingly, the samples of industry were collected for analysis of physicochemical properties (temperature, pH, electrical conductivity, COD, BOD, TSS, TN, TP, and ammonia). The physicochemical properties were measured following the procedures outlined by the American Public Health Association (APHA, 1999).

The temperature and pH values were measured in-situ, and other physicochemical parameters tests were done at the Environmental Laboratory of Addis Ababa City Environmental Protection and Green Development Commission. Data for physicochemical properties (2016-2018) of industries were obtained from Sabata town Environment, Forest, and Climate Change Authority (EFCA). The collected data for the year 2016-2018 was from the same industries data except upstream (control) and downstream and collected data on two seasons (dry and wet season) in 2019. Data from Sabata river was collected following river bank from three location such as upstream (no industry), middle stream (industry start) and downstream in dry and wet season.

Sampling Techniques

The criteria for sampling sites selection was based on baseline setting of the upstream Sabata River (control), and the treatment group (middle stream and downstream) as well as wastewater from industry (treatment) and upper stream (control). The sampling sites were marked using GPS reading and GIS mapping for sampling sites (Figure 3.1 and Table 3.1).The composite sampling techniques were utilized to collect wastewater from industries in dry(April-May) and wet (June-July) seasons and quantified physicochemical properties using graphite atomic absorption spectrophotometer. While, water temperature, and pH were quantified in-situ. The sample from Sabata River (one liter), and industrial wastewater (one liter) were collected in plastic bottles washed with nitric acid and distilled water before sample collection.

The physicochemical parameters such as temperature, EC, ammonia, COD,TP, TN,TSS, pH, and BOD were analyzed using pH meter of VWR pH110 (range -10.0 to 120^{0}C, accuracy ± 0.5 ^{0}C, and resolution 0.1 ^{0}C), conductivity meter, Nessler method, reactor digestion method, ascorbic acid method, Kjeldahl method, photometric method, pH meter of VWR pH110, and sensor method. The quality assurance was made using quality control methods such as standard protocol, washing plastic bottles, calibration, analysis of reagent blanks, de-ionized water, and standard solution.

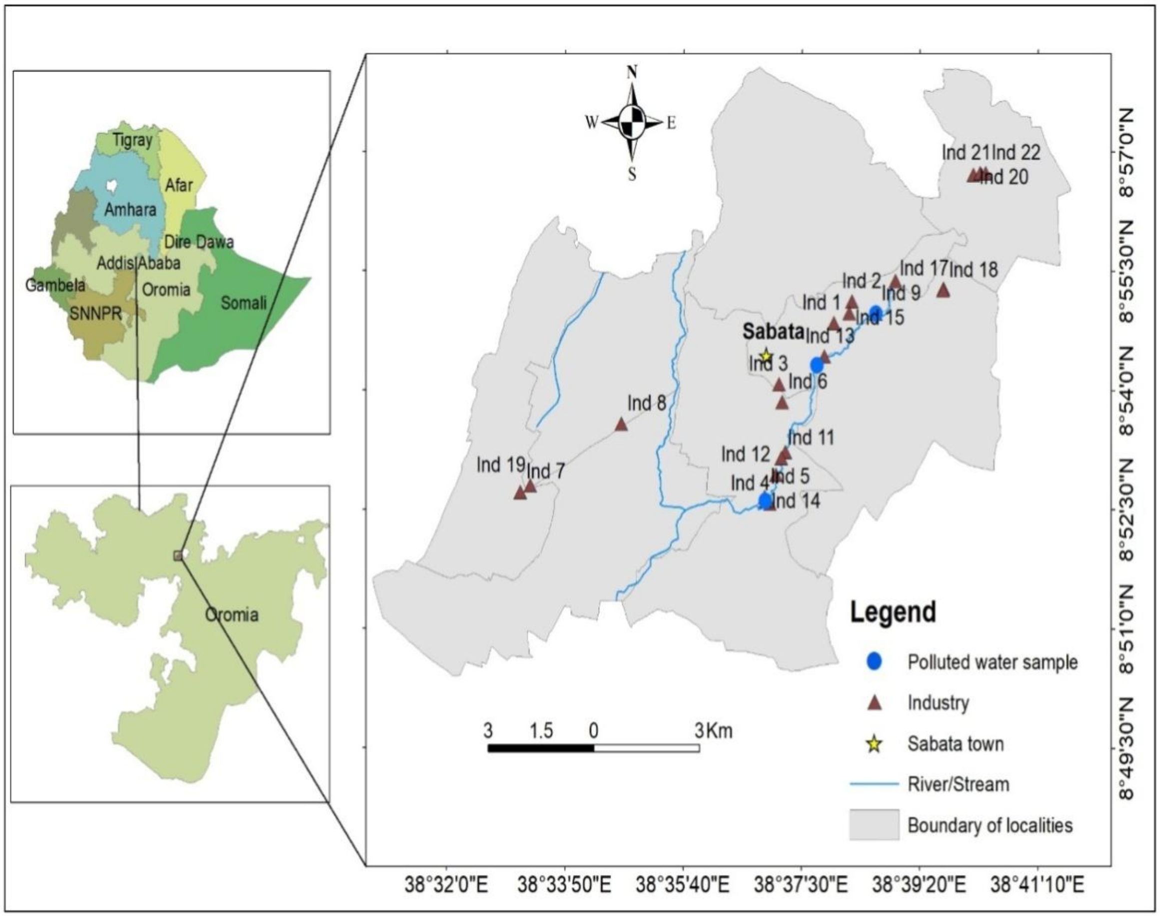

Figure 3.1 Map of Ethiopia showing the distribution of sampling sites

Table 3.1 The coordinate of sampling points

Industry	Description	Lat.	Long.
Ind 1	National Alcohol and liquor factory	8.914131	38.63333
Ind 2	Balezaf alcohol and liquor	8.918617	38.63804
Ind 3	Industrial wastes on Atebella Chaffe	8.901227	38.61922
Ind 4	Sabata river Atabela	8.876256	38.6169
Ind 5	Nova water	8.877615	38.6155
Ind 6	Meta Abo Brewery S.c	8.897578	38.62006
Ind 7	Yes mineral water plc	8.878635	38.55236
Ind 8	Yes Brands and Beverages	8.892947	38.57842
Ind 9	Arba Minch textile plc	8.916143	38.6442
Ind 10	Zalash cosmetics and plastics	8.887058	38.62081
Ind 11	Sabata Abattoir	8.885746	38.61985
Ind 12	Steel smelting factory	8.882298	38.61839
Ind 13	Arba Minch textile factory	8.907067	38.63088
Ind 14	Plastic industries	8.876844	38.6157
Ind 15	Pacific industrial Plc	8.916174	38.63735
Ind 16	Hafde Tannery	8.922916	38.64924
Ind 17	Walia steel industry	8.921362	38.66173
Ind 18	Ayka Addis textile and Investment group	8.920971	38.6616
Ind 19	Home Tech factory	8.880072	38.55494
Ind 20	HPM modern pipe plastic	8.945262	38.66943
Ind 21	Cable factory	8.945594	38.67112
Ind 22	Cement industry	8.945532	38.67258

Quality assurance

The analysis instrumental parameter deployed following the burner 100 mm, HCL lamp, and single beam optical mode. The blank limit assumes sample containing no analyst or contrition of analyst 0 unit, which means zero level of calibration. The Atomic absorption spectrophotometer (analytikjena, German, type NOVAA 400P) was used. The method of detection implies sample contain low contrition of analyst, dilution of lowest contrition of calibrator or Analytical Jena

NOVAA 400. The Graphite method was used with 10-4 mg/L. The quantification limit sample was containing low concentration of analysis at the expected limit of quantification for NOVAA 400 10-4 mg/L or above its base limit. The physiochemical parameters of industrial wastewater and river water were examined and quantify the level of physiochemical by using AAS.

Statistical analysis

The physicochemical data were recorded, organized, and analyzed using R software (version 3.4) and Microsoft Excel. The physicochemical properties values were compared with World Health Organization (WHO), World Bank (WB), United Nations Industrial Development Organization (UNIDO), India Standard Institute (ISI), Bureau of Indian Standards (BIS), Federal Democratic Republic of Ethiopia Environmental Protection Agency (FDRE EPA), National Water Quality Standards (NSDWQ) of Malaysia, Indian Council for Medical Research (ICMR), World Health Organization (WHO), UK General Quality Assessment (UK GQA), and Canadian Council of Minister for Environment (CCME) standard for water quality and interpreted as above permissible limit or not. The data were analyzed with one-way Analysis of Variance (ANOVA), mean, and standard deviation and statistically significance when $P<0.05$ using R software (version 3.4).

Results

Analysis of physicochemical properties of industrial industrial wastewater (2016-2018)

Temperature and pH

The water temperature of samples ranged between 21 and 37.2 ^{0}C (Table 5.2) which was above the permissible limit recommendation by UNIDO (15^{0}C), CCME (15^{0}C), and WB (15 ^{0}C). The pH value of the alcohol and liquors and tannery industries were 4.0 and 4.7 log units, respectively. The pH value of industrial wastewater from alcohol and liquors and tannery were acidic. Whereas, the pH value of brewery was alkaline (Table 3.2). The pH value of tannery, and liquors and alcohol industries were not within the permissible limits recommended by WHO (6.5-9.2). The low pH concentration values were recorded in alcohol and liquors, and tannery, respectively. This low pH depicts that a high acidity with high chemical toxic pollution of the environment.

Electrical Conductivity (EC)

The EC ranged between 1200 and1870 µs/cm (Table 3.2) and these values are above the permissible limit endorsed by WHO (2010) for all industries except Arbamich textile, Mahiber textile, and alcohol and liquors factory. The highest concentration of EC was detected in tannery and agro industry in the area (Table 3.2).

BOD and COD

The highest BOD concentration was recorded in alcohol and liquor, and tannery industries (Table 4.2). BOD ranged between 37.2 and 4880 mg/L (Table 3.2) and these values were above the permissible limit set byWHO in all industries. The BOD values were greater than 12 and 15 mg/L suggesting the occurrence of pollution of Grade F, which implies bad water conditions as per the standard recommendation by UK GQA BOD category. The COD ranged between 90 and 14928 mg/L was surpassed the permissible limit set by WHO (1996) of 80 mg/L in all industries and thus implies grossly polluted of > 80 mg/L (Table 3.2).Thus, high concentration of BOD and COD were detected in alcohol and liquors,and tannery factories in the area.

TSS and Ammonia

The TSS values were between 135 and 860 mg/L (Table 3.2) which was above the permissible limits recommendation by WHO (50 mg/L) for alcohol and liquors factory,Agro-industry, textile, and tannery industrie. The TSS values of alcohol and liquors, and agro-industry depict that the grossly polluted status of water condition compared to the standard set by WHO (2004) (>278 mg/L).

Ammonia, Total Phosphorus (TP), and Total Nitrogen (TN)

The TP values ranged between 1.91 and 12 mg/L (Table 3.2) and these were above the permissible limit of BIS (1.0 mg/L) in the textile, brewery, alcohol and liquors, agro industry, and tannery industries. The TP concentration was also categorized based on standardset by UNIDO (2003) as oligotrophic (<5 mg/L), mesotrophic (5-25 mg/L), eutrophication level (28.5-30 mg/L), eutrophic (25-250 mg/L) and hypertrophic (>250 mg/L) and thus, brewery, alcohol and liquor factories were categorized in the mesotrophic.The TN concentration value was within standard set by WHO in all industries except Ayka textile, tannery, and alcohol and liquors factory. The ammonia value was also above the permissible limit recommendation by WHO (2010) (1.5 mg/L) in all industries. In nutshell, the proportions of concentration of the EC, COD, BOD, and TN in industries were estimated to be 53 %, 32%, 9%, and 2%, respectively.

Table 3.2 Analysis of physicochemical parameters of industries (2016-2018)

Year	Industries	Temperature (^{0}C)	EC, µs/cm	pH	BOD, mg/L	COD, mg/L	TSS, mg/L	Ammonia, mg/L	TN, mg/L	TP, mg/L
2016	Arbamich Textile S.C	37.2	887	8.59	37.2	115.75	15	ND	4.33	2.18
	Mahavier Textile Plc	32	920	6.95	144	44.16	25	12.89	24	12
	Jiadong Textile plc	29	1210	7.03	89.62	714	23.33	2.83	ND	1.04
2017	Meta Abo Brewery S.c	23	1320	8.3	240	90	ND	1.71	17.32	5.47
	Balezaf Alcohol and Liquors	28	876	4	4880	14928	860	17.8	151.41	11.1
	Sabata Agroindustry	25	1560	6.46	300	711.2	770	10.48	18.72	3.63
	Hafede Tannery	31	1780	4.7	1024	251733	135	49.79	56508	4.1
	Ayka Addis Textile and Investment Group	34	1320	6.5	42.24	157.92	10	0.53	3.64	2.4
2018	Ayka Addis Textile and Investment Group	21	1200	7.31	173.64	352.8	290	39.06	58.59	1.91

NB: ND means not detected

Analysis of physicochemical properties of industrial wastes (2019)

Temperature and pH

The results of the analysis of physicochemical parameters of wastes discharged from factories during the field survey (2019) were presented in Table 3.3. The water temperature of samples ranged between 18 and 30.8 ^{0}C (Table 5.3) which was above the maximum permissible limit set by UNIDO (15 ^{0}C), CCME (15^{0}C), and WB (15^{0}C).

The pH value ranged between 4.5 and 4.7 log units (Table 3.3) which was recorded in alcohols and liquors factory, tannery during dry season and alcohols and liquors during both seasons (Table 4. 3). The low pH values were recorded in the tannery and alcohols and liquors factory depicting the acidity of discharged industrial wastewater in the area. Similarly, the pH values recorded were above permissible limit of WHO (2010) (6.5-8.5 log units). Specifically, the low pH concentration value was recorded in tannery and alcohol and liquors factory.

Electrical conductivity, EC

The EC value ranged between 2389 and 10450 µs/cm (Table 3.3) which was above the permissible limit in all sample sites except for the upper stream (Table 3.3) of FDRE EPA (2003) (1000 µs/cm). For instance, the EC value of tannery during the dry season was 10,470.05 µs/cm at 25^{0}C. Specifically, the highest EC concentration value was recorded in tannery (10470 mg/L in wet and 10450 mg/L in dry), textile (5710 mg/L in wet) and brewery in dry (5423 mg/L) and wet (5450 mg/L) season in 2019.

BOD and COD

The BOD values ranged between 20 and 460 mg/L (Table 3.3) and these are above the permissible limit of WHO (<6 mg/L) (Table 5.3).The highest physicochemical concentration value was recorded for COD and BOD in the area. The high concentration COD value was recorded in the tannery and alcohol and liquors industry in the dry and wet season. The highest concentration value of BOD was recorded in tannery and alcohol and liquors factories. Generally, the physicochemical properties were decreasing in order of EC>COD>BOD>TN>ammonia>temperature>pH.

Table 3.3 Results of physicochemical properties of industrial wastewater from industries (2019)

Seasons	Sampling sites	Temperature, ^{0}C	EC, µs/cm	pH, log units	BOD, mg/L	COD, mg/L	TSS, mg/L	Ammonia,mg/L	TN, mg/L	TP, mg/L
Wet	Ayka Addis Textile	30	5700	7.8	35	33	41.3	28	34	0.5
	Meta Abo Brewery	18	5400	4.5	270	150	132.3	68	83	11.5
	Alcohol and Liquors	25	2389	4.5	ND	2380	143.3	60	70	2.2
	Hafde Tannery	21	10450	7.5	460	4970	621.5	670	810	30.2
	Agro-industry	30.1	5489	7.7	45	37	34.2	28	23	0.4
	Upper stream	2	603	7.4	20	24	21.3	10	13	0.0001
	Downstream	28	5360	6.5	253	310	176.3	240	290	1.4
Dry	Ayka Addis Textile	30.8	5710	7.9	38	58	44	4.5	33	0.0001
	Meta Abo Brewery	23.8	5450	8.6	148	271	148	30.5	250	11.6
	Alcohol and Liquors	26	2390	4.7	ND	2900	228	2	25	1.4
	Hafde Tannery	21.9	10470	4.95	464	5450	725	51	460	3.1
	Agro-industry	30.7	5490	7.7	46	55	47	6	36	0.0001
	Upper stream	22.5	604	7.5	22	27	34	3.5	10	0.0001
	Downstream	29	5410	7	256	1025	248	2	38	1.4
Range	Ayka Addis Textile	30-30.8	5700-5710	7.8-7.9	35-38	33-38	41.3-44	4.5-28	33-34	0.5-0.0001
	Meta Abo Brewery	18-23.8	5400-5450	4.5-8.6	148-270	150-271	132.3-148	30.5-68	83-250	11.5-11.6
	Alcohol and Liquors	25-26	2389-2390	4.5-4.7	ND	2380-2900	143.3-228	2-60	25-70	1.4-2.2
	Hafde Tannery	21-21.9	10450-10470	4.95-7.5	460-464	4970-5450	621.5-725	51-670	460-810	3.1-30.2
	Agro-industry	30.1-30.7	5489-5490	7.7	45-46	37-55	34.2-47	6-28	23-36	0.4-0.0001
	Upper stream	22-22.5	603-604	7.4-7.5	20-22	24-27	21.3-34	3.5-10	10-13	0.0001
	Downstream	28-29	5360-5410	6.5-7	253-256	310-1025	176.3-248	2-240	38-290	1.4
Mean	Ayka Addis Textile	30.4	5705.0	7.85	36.5	35.5	42.65	16.25	33.5	0.25
	Meta Abo Brewery	20.9	5425.0	6.55	209	210.5	140.15	49.25	166.5	11.55
	Alcohol and Liquors	25.5	2389.5	4.6	ND	2640	185.65	31	47.5	1.8
	Hafde Tannery	21.45	10460.0	6.23	462	5210	673.25	360.5	635	16.65
	Agro-industry	30.4	5489.5	7.7	45.5	46	40.6	17	29.5	0.20
	Upper stream	22.25	603.5	7.45	21	25.5	27.65	6.75	11.5	0.0001
	Downstream	28.5	5385	6.75	254.5	667.5	132.15	121	164	1.4

Results of spatial and seasonal variation of physicochemical properties

The physicochemical parameters of river water samples from different locations along the Sabata River were analyzed during the wet and dry seasons. Samples from the upper stream of the Sabata River had low values for the physicochemical parameters estimated.

Temperature, pH, and EC

The water temperature was above the standard limit (see Table 3.4) of UNIDO (15 ^{0}C), CCME (15 ^{0}C), and WB (15 ^{0}C) in the upper stream, middle stream, and lower stream of Sabata river in wet and dry season. However, pH value was within standard limit set by WHO (7-8.5) log units in the Sabata River. However, the pH value was not within standard limit set by WHO (2004) (6-9) log unit in downstream in the wet season (4.9 log unit).The EC value was above safe limit recommended by WHO 2010 (500 µs/cm) in the Sabata river.

BOD and COD

The BOD values were higher than the permissible limit set by WHO (2004) >12 mg/L in all parts of Sabata River (Table 3.4). Based on UK GQA grade and values for BOD, the Sabata River was recorded BOD value above 15 mg/L of BOD that make this river categorized in grade F and bad water quality status. The COD value was above standard limit endorsed by WHO (2004) 10-80 mg/L in the Sabata river in the downstream (14,545 and 13,459 mg/L), and middle stream (12,345 and 12,432 mg/L) in dry and wet season respectively that indicate grossly polluted as WHO (2004) (>80 mg/L).

TSS and Ammonia

The TSS values were higher than the recommended limit set by ISI (500 mg/L), and WHO (200-350 mg/L) in the downstream and middle stream in both dry and wet season of Sabata river (Table 3.4).Ammonia value was above standard limit for quality water set by WHO (2010) (1.5 mg/L) in the dry and wet season in the area.

Generally, the physicochemical properties of Sabata river was not significant ($p>0.05$) for pH, temperature, and EC in all part of the river, TSS highly significant ($p>0.05$) in lower and middle stream, ammonia very highly significant ($p>0.05$) in downstream, and BOD highly significant ($p>0.05$) in the downstream and middle stream. Furthermore, high concentration value of physiochemical properties was observed in COD followed by BOD, EC, TSS, temperature, and pH in that order during both seasons in the study area (Figure 6).The temperature, pH, BOD, COD, TSS, Ammonia, and EC in downstream was above permissible limit for river water endorsed by WHO in Sabata river of Ethiopia. Similarly, the high concentration values of physicochemical properties were recorded in COD, BOD, and EC in the downstream and middle stream of the Sabata river.This indicates the need to safeguard the river water from untreated industrial wastewater discharge from industries in the area

Table 3.4. Results of physicochemical properties of water in Sabata River

Season	site	Temp., ^0C	EC, μs/cm	pH	TSS mg/L	BOD, in mg/L	COD, mg/L	Ammonia-N, mg/L	TN, mg/L	TP, mg/L
Wet	R1	23.4	167.8	7.7	48.0	54.0	234.0	2.2	0	0.37
Wet	R2	20.9	286.0	7.7	548.0	1350.0	12345.0	3.28	2.3	1.44
Wet	R3	20.3	1003.0	4.9	678.0	4895.0	13459.0	16.28	4.3	5.2
Dry	R1	20.9	192.4	7.7	43.0	57.0	245.0	3.36	0	0.49
Dry	R2	18.3	499.0	7.3	867.0	1460.0	12432.0	5.28	6.4	6.65
Dry	R3	20.3	2126.0	7.9	889.0	5467.0	14545.0	17.64	5.8	6.19
Range	R1	20.9-23.4	167.8-192.4	7.7	43.0-48.0	54.0-57.0	234.0-245.0	2.2-3.36	0	0.37-0.49
	R2	18.3-20.3	286.0-499.0	7.3-7.7	548.0-867.0	1350.0-1460.0	12345.0-12432.0	3.28-5.28	2.3-6.4	1.44-6.65
	R3	20.3	1003.0-2126.0	4.9-7.9	678.0-889.0	4895.0-5467.0	13459.0-14545.0	16.28-17.64	4.3-5.8	5.2-6.19
Mean	R1	22.5	180.1	7.7	45.5	55.5	244.0	2.78	0	0.43
	R2	19.3	372.5	7.5	707.5	1405.0	12388.5	4.28	4.4	4.05
	R3	20.3	1564.5	6.4	783.5	5181	14002.0	16.96	5.1	5.69

N.B: R1-upperstream, R2 -middle stream, R3-Downstram.

Furthermore, physiochemical properties were statistically very highly significant (p>0.05) in temperature, BOD, COD, EC, TSS, TN, and TP in the treatment group (textile, brewery, agro-industry, alcohol and liquors, and tannery industries) in 2019 (Table 3.5).

Table 3.5 ANOVA results as function of industrial wastewater, 2019

Parameters	Group	Mean ± SD	Pr (>0.05)
Temperature	Control	3.61±3.6100	0.0002303 ***
	Treatment	215.88±30.8396	1.348e-08 ***
pH	control	0.0315±0.0315	0.8142
	treatment	23.5852 ± 3.3693	0.0130 *
Ec µs/cm	Control	900±900	0.04159 *
	Treatment	114936676±16419525	< 2e-16 ***
BOD, mg/L	Control	600±600	0.4607
	Treatment	324480±46354	2.327e-05 ***
COD, mg/L	Control	273006±273006	0.03071 *
	Treatment	47237062±6748152	2.31e-07 ***
TSS, mg/L	Control	42±42	0.004678 **
	Treatment	708382±101197	1.467e-15 ***
TN mg/L	Control	3335±3335	0.540885
	Treatment	475932±67990	0.005855 **
TP mg/L	Control	0.81 ±0.810	0.06714
	Treatment	1453.60±207.657	3.086e-10 ***

Discussion

The amount of wastes discharged from manufacturing industries in the Sabata area has not been estimated. However, the factories have released chemical wastes, heavy metals, and others into water bodies or open fields. The present study on the physicochemical parameters of the Sabata River showed that a high concentration values of COD, BOD, and EC in the downstream in the area.Similarly, most operating industries in Ethiopia have not waste treatment plants, discharge their untreated effluent to the adjoining rivers, not properly functioning treatment plants, sources of problem to the environment and the neighboring communities (Tsegai, 2015).Likewise, the COD and BOD in the middle and downstream parts of Kechene-Kurtumie-Bantiyketu and

Kebena River of Addis Ababa city showed varied concentrations due to natural purification capacity and dilution of river water (AARDP, 2017). EC in Kechene-Kurtumie-Bantiyketu and Kebena rivers of Addis Ababa City were above WHO permissible limit due to the presence of much-dissolved cation and anions in the river (Ibid). Clarke (1994) study conform to the present study that physicochemical properties of river water disruption were caused by anthropogenic activities such as increasing population, urbanization, and industrialization that resulted in declining ecosystem services.

The temperature (tannery, textile and agro-industry), pH (tannery and alcohols and liquors), BOD (tannery, alcohol and liquor), COD (textile, brewery, and agro-industry),TSS (all industries except upstream, Arbamich textile, Mahiber textile, and alcohol and liquors factory) and EC (downstream of Sabata river) were above permissible limit recommended by WHO in Sabata industry area.The studies on industrial wastewater from the paint industry of Nigeria was conform with the present study implying ineffective in reducing the TSS, BOD, and COD to acceptable limits (Aniyikaiye et al., 2019). Similarly, the concentrations of BOD, COD, TSS, and pH levels were above the permissible limit recommendation by FDRE EPA in Dukem town textile industrial industrial wastewater area of Ethiopia (Diriba *et al*., 2017).Furthermore, the physicochemical of pH, EC, TDS, TSS, and COD of industrial wastewater from paint industries in Addis Ababa were above the permissible limit set by ES and WHO (Berihun D, and Solomon Y, 2017).

The temperature, pH, BOD, COD, TSS, Ammonia, and EC in downstream was above permissible limit for river water endorsed by WHO in Sabata river of Ethiopia. Similarly, the temperature, pH, conductivity, BOD_5, and ammonia were beyond permissible limit of WHO for river water (Tamiru, 2015).Similarly, the physicochemical water quality of Lake Victoria was negatively affected by industrial wastes with high values of BOD (Seth, 2015). Also, higher levels of temperature, EC, and low pH were reported due to increased solubility of ions in the area (Seth, 2015). Likewise, Awash River was categorized as poor and marginal, and poor and fair water quality in the upper basin and middle/lower basin respectively (Amare *et al.*, 2017). However, low pH does not mean low impact rather higher toxic acid component with an adverse effect on water quality in the area. Agaje (2007) study was also conform with the present study with the BOD level above the permissible limit of industrial waste loads in Akaki Kality and Eastern Akaki River. This study was complying with the physicochemical properties study of the Sabata River. Other studies on physicochemical levels of the Bisnit river of Ethiopia reported similar results to our observation (Tamiru, 2015). On the contrary, temperature and pH was within the permissible limit at downstream of both Modjo and Akaki rivers (Abrha, 2015) and Kechene-Kurtumie-Bantiyketu and Kebena rivers (AARDP, 2017).

The pH, temperature, and EC were not significant in all parts the of Sabata river. The TSS, Ammonia, and BOD were highly significant in lower stream and middle stream, very highly significant in downstream and highly significant in the downstream and middle stream of the Sabata River, respectively. On the contrary, the pH was highly significant in wet season in Victoria Lake (Seth, 2015). Similarly, the BOD was highly significant in Victoria Lake (Seth, 2015).

The TP concentration value was higher in tannery in the Sabata area. The TP concentration value was the standard limit of eutrophic (FDRE EPA, 2003) in the tannery (2019), mesotrophic in brewery (2019), and oligotrophic levels in the rest of industries in Sabata town. This might be due to run off mixed up the agricultural farm fertilizer with industrial wastes in the area. However, The present study was also consistent with the TP concentration value in the stream of

Bisinit of Gondar of Ethiopia eutrophic level (FDRE EPA, 2003;Tamiru, 2015).Similarly, the phosphate was above the permissible limit except at the source in Kechene-Kurtumie-Bantiyketu and Kebena rivers (AARDP, 2017).

Generally, the high concentration value of physiochemical properties was observed in COD followed by BOD, EC, TSS, temperature, and pH in that order during both seasons in the study area. Moreover, the high concentration values of physicochemical properties were recorded in COD, BOD, and EC in the downstream and midstream of the Sabata River. This indicates the need to safeguard the river water from untreated industrial wastewater discharge from industries in the area. Similarly, the concentrations of BOD, COD, TSS, and pH levels were above the permissible discharge limit of Ethiopia EPA in Dukem town textile industrial industrial wastewater and thereby, the local environment, people, and their livestock highly exposed to contaminated industrial industrial wastewater (Diriba *et al*., 2017).Thus, a large number of these industries of tannery, alcohol, soap, brewery, plastic factories, and other factories situated in Sabata town, however, they release their industrial wastewater into rivers without any treatment that might be a point source of environmental pollution that affect human and animal health.

Conclusion

This study investigated the concentration level of the physicochemical properties of industrial wastewater from industries signaling environmental pollution in the area. The physicochemical properties concentration value was evaluated against the international standard for water quality in the area. The level of BOD, COD, and TSS were above the standard endorsed by WHO and implying pollution of the water in the area. A similar trend was observed in industrial wastewater from all factories studied during the years 2016-2019. The pH concentration value of the industrial wastewater from alcohol and liquors and tannery factories (2017) were beyond the permissible limit. Furthermore, the level of physicochemical properties such as temperature, BOD, COD, EC, TSS, TN, and TP depicted statistically significant in all industries during 2019 except upperstream. This indicates the adverse impact of industrial industrial wastewater on the water quality in the area.

The result of this study depicted that the EC,BOD, COD, and pH value were above the standard set by WHO along the studied Sabata River. This portrayed the water quality of Sabata river was adversely disrupted and thereby, not suitable for drinking, farming, and industrial uses.The TSS, ammonia, and BOD were also quite significant in the downstream and middstream of the River. These industrial wastes often discharge either untreated or only partially treated wastes openly into the environment, and affecting the local community health, livestock, wetland, and vegetable farms.

Furthermore, Ethiopia has not implemented maximum permissible safe limit for concentration of physicochemical of industry wastewater release into water bodies (rivers or streams) and others. Industrial wastewater from such industries were not managed in the systematic way using waste treatment technologies. This may result in a high concentration of physicochemical that may disrupt the environment. To tackle the adverse impact of the industrial wastes, an integrated and area specific approach of industrial waste management were required for industries waste management. Thus, the government should take this into account and devise mitigation strategies through enforcing existing standard of industrial pollution control regulation, installation of treatment plant, transforming of industrial residual into biogas products, awareness creation for the society, initiation of sustainable corporate industrial responsibility, and the implementation of environmental protection regulation.

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Paper IV Occurrence of heavy metal in water, soil, and plants in fields irrigated with industrial wastewater in Sabata town, Ethiopia

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Abstract

Industrial wastes have been increasingly discharged into water and soil, and causing environmental pollution in Ethiopia. This study examined the occurrence of heavy metal in water, soil, and plants in fields irrigated with industrial wastewater in Sabata town, Ethiopia. The composite samples of soil, water, and vegetables were collected accordingly to determine the concentration of heavy metals (Cu, Pb, Zn, Mn, and Ni) in each system during dry and wet seasons. The concentration of heavy metal was assayed using atomic absorption spectrophotometry. The data were statistically analyzed using one-way ANOVA. The heavy metal concentration was decreased in the order of Pb > Mn > Ni > Cu > Zn, Mn > Ni > Pb > Cu > Zn, and Ni > Pb > Mn > Cu > Zn in the water, soil, and vegetables in the area respectively. The variation of levels of heavy metal in the water, soil, and vegetable might be because of the effect of heavy metal speciation and valence, industry types, vegetable types and tissues, and soil. The bioconcentration factor of heavy metals was higher than one for copper, signifying the increased probability of health risk for those who are consuming vegetables grown in the area. Thus, the government should take this into account and devise mitigation strategies through the implementation of heavy metal removal systems from contaminated water and soil, waste management strategies of recycling, centralized or decentralized treatment plant, changing of industrial residual into biogas production, and awareness creation for the society.

Keywords: Industry, Heavy metal, Bioaccumlation factor, Sabata, Ethiopia

Introduction

The manufacturing industry is an important sector for economic growth of the country. However, the wastes emitted from the industries can pollute the soil and aquatic ecosystem since mitigation strategies are lacking in developing countries. This can pose considerable health impacts to the community exposed to water or vegetables grown on areas affected with industrial wastes (Landrigan *et al.* 2018). Farmers living in heavily contaminated areas near big cities are increasingly using industrial wastewater for irrigation because of the lack of access to freshwater (Landrigan *et al.* 2018). Industrial wastewater containing heavy metals have been used for irrigation purposes in many developing countries (Minbale *et al*. 2015). The use of wastewater for irrigation can result in the accumulation of nonbiological degradable heavy metals in the soil and tissues of vegetables (Minbale *et al*. 2015), causing environmental pollution (Barakat 2011), gastrointestinal cancer risks in humans (Türkdoğan *et al*. 2003), and physiological disorders (Arora *et al*. 2008).

The study carried out in Ghana on vegetables showed that 81% of them contain heavy metals higher than the EU limit (Donkor *et al*., 2017). This revealed that the consumption of raw or semi-processed vegetables containing high levels of heavy metal may result in health risks (Donkor *et al*. 2017). It has been shown that high levels of heavy metals in foodstuffs resulted in deranged biological and biochemical processes in the consumers (Begum & Harikrishna, 2010). Moreover, the accumulation of heavy metals in the human body can result in developmental abnormalities in the offspring (Akoto *et al*. 2008; Begum &Harikrishna 2010). Akoto et al. (2008) showed that toxic heavy metals have adversely affected the aquatic system. Due to this fact, most of the developed countries developed accretion systems of Potential Harmful Elements (PHEs) such as lead (Pb) (Plant et al. 1996) for having carcinogenic and adverse birth defects

(WHO 1998; Plant et al. 1996). The effects of such chemicals on the environment, humans, and animal health have grown owing to pollution in developing countries that originated from developed countries (Plant et al. 1996).

Many industrial activities pollute the air, water, and soils by releasing heavy metals that affect aquatic life, human health, food security, nutrition quality, and other water bodies (Rodriguez, E, N., *et al.* 2018). The accumulation of heavy metals such as lead (Pb), copper (Cu), zinc (Zn), and nickel (Ni) in the soil may affect soil properties and inhibit plant growth (Rodriguez.E. N., *et al.* 2018). Specifically, Cu, Ni, and Zn are the natural pedo-geochemical origin and relatively toxic to plants (Kim, Chori and Chang 2011). On other hand, Pb is relatively highly toxic to higher animals. It is absorbed and translocated to plant tissues from which it affects animals and humans when consumed with plants (Rodriguez, E. N., *et al.* 2018). Copper, manganese (Mn), Ni, and Zn reached phytotoxic levelin plants (McBride, 1994; Rodriguez., *et al.* 2018). Therefore, soil pollution reduces food security and safety by reducing crop yields as well as rendering them unsafe (FAO and ITPS 2015; Rodriguez, E.N., *et al.* 2018).

Establishment and expansion of industries is currently up surging in Ethiopia (Zinabu *et al*. 2018). About 90 % of the industries release wastewater into nearby water bodies (G.Gebre & D Van Rooijen 2009). Zinabu *et al.* (2018) showed that poor monitoring and release of untreated industrial wastewater, lack of expertise on pollution, weak environmental management system, and unclear measures taken on pollutant firms prevail in Ethiopia. There are tanneries, textiles, and coffee processing industries causing significant pollution of soil, water, and aquatic ecosystems, posing harm on water users (Asfaw 2007; Abera 2014; Reda 2015; Tekle *et al.* 2015; Stephen et al. 2017). The social and environmental impacts of more than 97.1 % of the industries have not been studied including the effects open release of wastewater. Sabata town is one the industrial town in central Ethiopia where wastewater is released into nearby environment without regulation (Report of Oromia Audit General 2018). Currently, there are several manufacturing industries that release their wastewater in the town, which include metal working, paints, smelting, paper, welding, batteries, and food industries. This indicates that, industrial wastewater released from the industries containing heavy metals such as Cu, Ni, Mn, Pb, and Zn could have caused environmental pollution in the area. The effects of environmental pollution due to these heavy metals have not been documented. This study is, therefore, aimed to assess the occurrences of concentration of heavy metals in water, soil, and plants grown on soil irrigated with industrial wastewater in Sabata town, Ethiopia.

Materials and Methods

Description of the study area

The study area, Sabata town is located between 8^{0}53’38’’ N to 8^{0}59’58’’ N latitude and 38^{0}35’11’’E to 38^{0}39’33’’E longitude. Sabata was selected because of the concentration of manufacturing industries such as metal, food, paper, alcohol and liquors, brewery, and textile factories in the area with minimal or no waste management. In addition, there are rivers in the area to which industrial wastes were discharged including Awash River, which is the largest river used for irrigation purpose. The total land coverage of the Sabata town was about 9,827 and 17,503 ha in 2008 and 2018, respectively (OUPI 2019). This shows an expansion of urban area in which large land area was engulfed by the urbanization, most of which is used for establishment of manufacturing industries.

Sampling Design

The laboratory test methods and procedures used were based on the standard methods and the guidelines described for quality of drinking water (Herschy 2012), and according to the procedures of the American Public Health Association (APHA 1999). The composite samples were collected from river water, soil, and vegetables from Sabata industry area. The geographical coordinates of the sample points for the Sabata River, soil, and vegetables were recorded using Global Positioning System (GPS) and mapped using Geographical Information System (GIS) as depicted in Figure 4.1.

The composite samples of soil, water, and vegetables were collected to determine the concentration of heavy metals (Cu, Pb, Zn, Mn, and Ni) in each samples during dry (April/May) and wet (June/July) seasons in 2019. The collected samples were transported using icebox at a temperature of 4^0c in polyethylene bottles to the Environment laboratory of Addis Ababa City, Environment and Green Development Commission within less than eight hours. Codes, names, and sources of the samples were labeled on the plastic bottles for traceability.

Sampling technique or procedures

The composite samples were collected from vegetables (red beet, lettuce, and cabbage) grown on soil irrigated with wastewater considered as treated group and garden cabbage considered as control group; soil from the treatment group (irrigated farm, forest, and wetland) and control group (rainfed farm); and water from treatment group (middle stream and downstream) and control group (upstream). The collection was done twice one during wet season and the other during dry season. The samples were assayed for the concentration of heavy metals (Zn, Cu, Pb, Ni, and Mn). Accordingly, A total of 32, 64, and 64 river water, soil, and vegetable samples were collected with composite samples of 6, 8, and 8 during wet and dry season, respectively.

Data on water was collected from an open ditch at the junction of industrial wastewater with the Sabata River before it is mixed with the Sabata river. Plastic bottles were used to collected industrial wastewater from different locations along the Sabata River. A water sample of one liter was collected in clean high-density polyethylene (HDPE) plastic bottles, which were rinsed three times with distilled water before using them. The preservation of water samples was done by adding nitric acid to each sample. River water samples were collected from upstream (control), middle stream (where the industry started) and downstream (where irrigated vegetables were cultivated) of Sabata River. The concentration of heavy metals in river water was determined by using atomic absorption spectrophotometer (NOVA Aanalytical Jena) in the Environmental laboratory of the Addis Ababa City, Environment Protection and Green Development Commission.

Digestion procedures for soil samples

The soil samples were plowed with a spade to draw soil samples. One kilogram of the surface vertisol soil was taken at 20 cm depth from the surface. The soil samples were collected in a polyethylene bag. They were ground, sieved, and oven-dried at 105^0C for 24 hours. Then, 1.000 gm of dried soil (105 ^{0}C) was transferred into 100 mL Erlenmeyer flask and moisten with 2-3 mL water to which 7.5 mL concentrated hydrochloric acid and 2.5 mL concentrated nitric acid were added under a fume hood. Then, the flask was covered with a watch glass and left overnight at room temperature under a fume hood. The soil was boiled gently for 2 hours on a hot plate at 100 ^{0}C. It is them cooled to room temperature; rinsed with 30mL water. The extract was filtered on an acid-resistant filter paper into a 100 mL volumetric with the clear filtrate. The process continued to rinse the digestion vessel and the residue on the filter paper several times with a small amount of hot (±50 ^{0}C) 2MHNO3 and allow it to cool and make to volume with the

2M nitric acid solution includes blank. The flask heated in a water bath (100 ^{0}C) for two hours. Thus, these solutions examined to determine the concentration of heavy metals in soil by using atomic absorption spectrophotometer (AAS).

Digestion procedures for vegetable samples

The composite vegetable samples were collected from the edible part of each type in the Sabata area. The samples were collected in a plastic bottle cleansed with nitric acid and distilled water before use. The tri-acid digestion process was used to extract Pb, Zn, Cu, Ni, and Mn from vegetables. About 1.000 gm of the samples dried at 105 ^{0}C was transferred into a porcelain crucible. The samples were precalculated on a hot plate or in the muffle furnace at 200 ^{0}C if the latter has ventilation shaft and opens the trap. The samples were calcinated at 450 ^{0}C until completely mineralized for at least 2 hours. The crucibles were removed from the muffle furnace using the tongs and placed directly on hot plate. Then, 5mL of 6MHNO3 was added and digested by gentle boiling until approximately 1mL remained and 5mL of 3MHNO3 was added and the extract reheated for 30 minutes. Then the warm solution was filtered into a 100 mL volumetric flask; the quantity to be transferred assured with a glass rod. The crucible and glass rod were rinsed several times with 1% HNO3; the residual recovered on filter. The filter was cooled; diluted to 100 mL with water. The flask was sealed with a stopper or with paraffin.

The Atomic absorption spectrophotometer (Analytik Jena, German, type NOVAA 400) was used for determination of the concentration of heavy metals (Begum &Harikrishna 2010). The analytic instrument was deployed with burner 100 mm, HCL lamp, and single-beam optical mode. With this analytic instrument, the Graphite method was used with 10^{-4}mg/L. The quantification limit was sample containing low concentration of analyte at the expected limit of quantification for NOVAA 400 10^{-4} mg/L or above its base limit.

The validity of the procedure was determined according to the certified manual provided by the Soil and Plant Analytical Laboratories Network of Ethiopia (SPALNE) and the National Soil Research Laboratory (NSRL).The quality controls involved analysis of blank samples containing no analyte or contrition of zero unit, meaning calibrated to zero and national standard solutions of heavy metals in the each time. The heavy metals in water, soil, and vegetable samples were assayed by electrothermal or graphite method with the detection limit of 1 unit per billion (PPB). The method of detection limit (MDL) and limit of quantification (LOQ) were determined based on standard operating procedure for determination of metals with atomic absorption Spectrophotometery of Environmental Laboratory Version and Laboratory Instrument work manual developed by Addis Ababa Environmental Protection Authority in 2010 (2002 E.C).

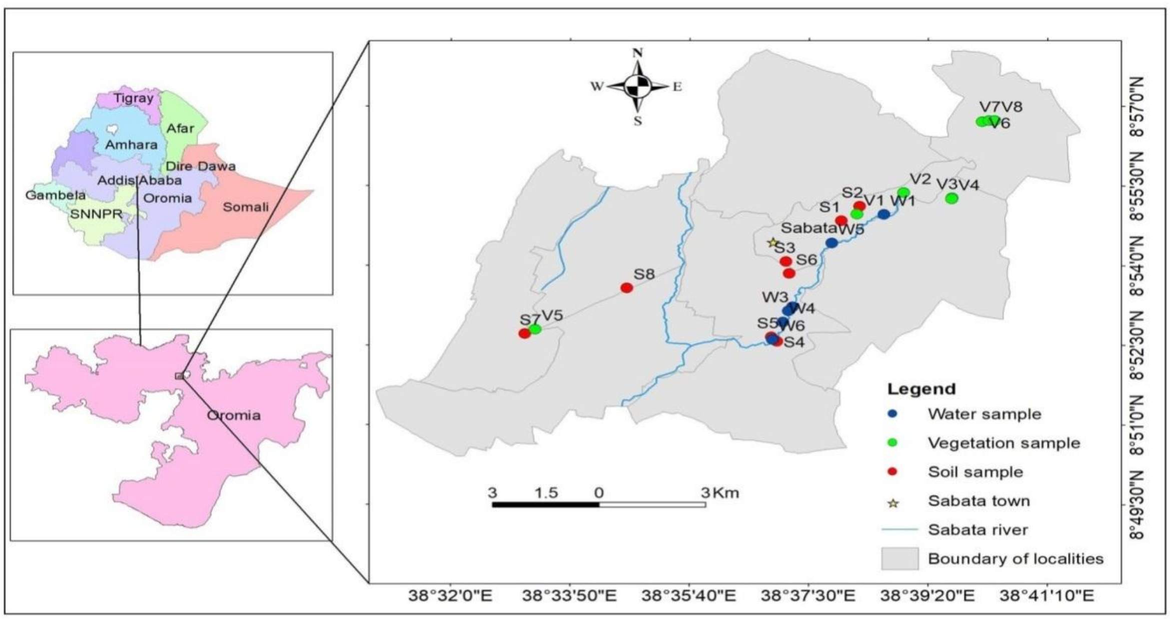

Figure 4.1 Map of Ethiopia and study area displaying the sample points of river, soil, and vegetables

Statistical Analysis

Descriptive statistics were used to analyze the occurrence of heavy metalsin water, soil, and irrigated vegetables in Sabata town. Analysis of Variance (ANOVA) was used to compare the concentration of heavy metals using R software version 3.4, Relative Standard Deviation (% RSD) and Principal Component Analysis and Pearson Correlation Coefficient by using IBM SPSS Statistics 22. The translocation of heavy metals from soil into vegetables was assayed by bioaccumulation factor (BAF) (Sharma *et al*.2018; Naser *et al*. 2012; Rattan *et al*. 2005; Gebeyehu and Bayissa 2020).According to Kachenko and Singh (2004), the bioacculmation factor of metal transfer from soil to a vegetable calculated:

$$BAF = \frac{C_{plant}}{C_{soil}}$$

The concentration of heavy metals was compared to an international standard as described by the U.S. Environmental Protection Agency (2010) Region III's risk-based concentration applied for health risk analysis. Daily intake of metals (DIM) was calculated as described by Chen *et al*. 2011; Gebeyehu and Bayissa 2020.

$$DIM = \frac{EFr \times ED \times FI \times MC}{RfD \times BW \times AT} \times 0.001$$

Where, ED = duration of human exposure for adult (ED) 30 (US EPA 1997a); duration of human exposure for child (ED) 6 (US EPA 1997a); dermal exposure factor to non-carcinogenic (ABS) 0.001 (US EPA 1997a); recommended daily vegetable intake 300-350 g/person (WHO,1998) ;AT non carcinogenic for adult consume 57 year (US EPA 1997a); AT non-carcinogenic for child 1 day (US EPA 1997a); surface area of adult skin in cm^2 18000 (US EPA 1997a); surface area of child skin in cm^2 6600 (US EPA 1997a); average ingestion rate for Adult in 0.345 kg (Latif *et al*. 2018); average ingestion rate for child 0.232 kg (Latif *et al.* 2018); estimated RfD for Cu is 0.04 mg/kg/day (USEPA IRIS 2006); estimated RfD in Pb is 0.004 mg/kg/day (USEPA IRIS 2006); estimated RfD for Ni is 0.02 mg/kg/day USEPA IRIS 2006; estimated RfD for Mn is 0.033 mg/kg/day (USEPA IRIS 2006); estimated RfD for Zn is 0.30 mg/kg/day (USEPA IRIS 2006); average weight of Ethiopia for Adult is 53.07 kg (CSA & WFP 2019); average weight children is 32.7 kg (Latif *et al*. 2018); average life expectancy of Ethiopia 65.48 year (MOH 2016); and average body weight of Ethiopia 53.07 kg (CSA and WFP 2019).

The method of estimating the risk using the THQ is based on the following equation (Abdu *et al*. 2011; Chen *et al.* 2011; Khan *et al*. 2008; Zhang *et al.*2007; Gebeyehu and Bayissa 2020):

$$THQ = \frac{EDI}{RfD}$$

The Hazard Index (HI) was analyzed as cumulative health risks of heavy metals in vegetables consumed (USEPA 2002) $HI=\sum_{N=1}^{i} THQ_n$; i=1, 2, 3……………………………………………n

The Target Hazard Quotient (THQ) was applied to estimate the non-carcinogenic risks of vegetable consumption (USEPA 1989; Chen *etal*.2011; Antoine *et al*. 2017; Khan *et al*. 2008; Zhang *et al*. 2007; Ezemonye 2019; Gebeyehu and Bayissa 2020). The safe limit value for THQ is ≤ 1 (USEPA 2011; Khan *et al*. 2009). This study also used principal component analysis (PCA) for data reduction and concentration loading analysis as well as the Pearson correlation coefficient for analysis of the association of parameter to heavy metal concentration.

Non-carcinogenic risks

The USEPA (2010) Region III's Risk-based concentration was applied to estimate the non-carcinogenic risks of vegetable consumption by using the Target Hazard Quotient (THQ). HQ does not provide a quantitative estimate of a reverse health effect rather an indication of health risk level due to exposure to pollutants (Chary *et al.* 2008; Jolly *et al*. 2013). The safe limit for THQ is ≤ 1 (USEPA 2011, Khan S.*et al.* 2009).

Quality assurance

Quality assurance is required to produce defensible data of known precision and accuracy. The quality assurance employed consists of quality assurance manual, written procedures, work instructions, and records. Quality system in the analysis includes all quality policies and quality control process demonstrated under the competency of the federal laboratory certification programs. Levels of trace metals in the environmental samples may be order of magnitude lower than in the potential sources of contamination. The contamination was removed by thorough cleaning of the containers with a metal free non ionic detergent solution, rinsing with tap water, soaking in acid, and rinsing with metal free water. The HNO3 or HCl was used to remove contaminants from the plastic materials. The study used replicates of measurable concentration to establish precision and known additions to determine bias. The laboratory analysis used blanks, calibrations, standards, and other ancillary measurements.

Results

Validation of the Method

The limit of quantification (LOQ) and the method detection limits (MDL) for all the metals considered in this study were calculated using a standard formula LOQ=3×SD and MDL=10×SD.The values for MDL and LOQ recorded in this investigation are presented in Table 1.It clearly showed that the instrument used has high sensitivity for the analysis. The samples and blank were examined as specified for atomic absorption spectrophotometer. The precision and accuracy of the method employed in this investigation of heavy metals in both soil and vegetable samples were given in Table 1. As can be seen from the data, the percentage of heavy metals in soil and vegetables and potential health risk relative standard deviations (%

RSD) were analyzed for all samples. The lower % RSD values were obtained was shown in Table 4.1.

Table 4.1 Results of analysis of heavy metals with specifications of AAS, SD & % RSD

Element	Wavelength (nm)	Lamp current(mA)	Check concentration, mg/L(0.1Abs)	MDL (µg/L)	LOQ (µg/L)
Cu	324.8	3	0.7	1	5-100
Pb	283.3	3	7.0	1	5-100
Mn	279.5	8	0.6	0.2	1-30
Ni	232.0	5	1.4	1	5-100
Zn	213.9	4	0.25	0.001	1.25

Vegetable	Standard deviation (SD)					Relative standard (% RSD)				
	Cu	Pb	Mn	Zn	Ni	Cu	Pb	Mn	Zn	Ni
Red beet	0.045	0.588	0.099	0.012	0.225	0.533	0.759	0.099	0.304	0.074
Lettuce	0.330	0.586	0.540	0.109	0.529	1.458	3.831	2.620	2.920	0.220
Cabbage	0.032	0.921	0.036	0.301	0.458	0.458	1.505	0.400	8.600	0.175
Forestland	0.141	0.86	0.549	0.071	0.186	0.822	0.788	0.070	1.200	0.085
Irrigated land	0.130	0.954	0.453	0.039	0.570	0.855	0.786	0.068	0.644	0.163
Wetland	0.504	0.726	0.693	0.015	0.843	2.488	0.462	0.038	0.264	0.188

Concentrations of Heavy metals in water, soil, and vegetables

ANOVA results of soil and vegetable

As shown in Table 4.2, the results of the concentrations of heavy metal in soil samples from different land-use systems revealed the highest levels Mn in the irrigated vegetable farms followed by wetland and forest land soils during both seasons. The concentration of the heavy metals was observed in decreasing of Mn>Ni>Pb>Cu>Zn in soil samples. The concentration of these metals was higher than the safe limit set by WHO, USEPA, and EU for all land-use systems during both seasons. The variation in the concentration of these metals among different soils types was statistically significant as shown by results ANOVA.

The concentration of heavy metals in vegetables showed different trends. The highest amount of heavy metal was recorded for Ni in lettuce cultivated on irrigated land followed by cabbage and red beet during both seasons. The results also showed that the concentration of Ni was (30.39 mg/kg) and (29.47 mg/kg) in lettuce during the wet and dry season, respectively. It was followed by cabbage (23.59 mg/kg) and (22.47 mg/kg) during the wet and dry season, respectively. It was lowest in red beet (21.39 mg/kg) and (20.67 mg/kg) during the wet and dry season, respectively. Higher concentration of Pb recorded in lettuce followed by red beet during both seasons. The levels of Pb and Mn followed a similar trend with that of Ni. In the garden cabbage, the concentration of Ni was (1.2 mg/kg) and (1.18 mg/kg) during the wet and dry season, respectively. Generally, the heavy metal concentration (mg/kg) in vegetables was decreasing in the order of Ni>Pb>Mn>Cu>Zn. The concentration of Cu, Pb, Zn, Mn, and Ni in vegetables was statistically significant for the treatment group. The highest concentration of Cu, Pb, Zn, Mn, and Ni were recorded in cabbage, lettuce, and red beet than the garden cabbage.

Table 4.2 Results of ANOVA of Heavy metals (mg/kg) in soil and vegetables samples

Sampling	Parameter	Types	Range	Mean± SD	Pr (>0.05)	USEP 1983)	EU (2002)	WHO	FAO/FAO
Soil	Cu	Control groups	1.18-1.20	0.00011±0.00011	0.853414		0.01		
		Treatment groups	1.39-1.88	0.48254±0.160846	0.003739 **				
	Zn	Control groups	0.40-0.60	0.000013±0.0000125	0.7888	0.05			
		Treatment groups	0.58-0.61	0.051737±0.0172458	0.0013 **				
	Ni	Control groups	34.8-35.03	10.060±10.058	0.217926	0.04	0.08		
		Treatment groups	0.01-43.8	474.930±158.311	0.006908 **				
	Mn	Control groups	67.8-68.01	0.100±0.100	0.5618	0.6	0.3		
		Treatment groups	5.8-185.01	17919.800± 5973.300	3.256e-07 ***				
	Pb	Control groups	8.90-9.01	0.033±0.0325	0.715134	0.01	0.3	0.1	
		Treatment groups	10.67-12.11	37.799±12.5998	0.003348 **				
Vegetable	Cu	Control groups	50-0.60	0.0002±0.00020	0.845410				0.001
		Treatment groups	0.51-2.20	3.4649±1.15497	0.000401 ***				
	Pb	Control groups	0.51-0.62	0.000±0.000	0.974				0.001
		Treatment groups	5.87-7.67	40.718±13.573	3.397e-05 ***				
	Mn	Control groups	0.20-0.21	0.0006±0.00061	0.03535 *				0.001
		Treatment groups	5.87-7.67	6.3561±2.11871	1.708e-07 ***				
	Ni	Control groups	1.18-1.20	0.970±0.966	0.06232.				0.001
		Treatment groups	20.67-23.59	913.710±304.570	1.238e-05 ***				
	Zn	Control groups	0.52-0.53	0.0002±0.000200	< 2.2e-16 ***				
		Treatment groups	0.88-2.79	0.0370±0.012333	< 2.2e-16 ***				

Pearson's correlation coefficient (r) results of soil and vegetable

The results of Pearson's correlation revealed that the concentration of the heavy metals showed strong correlations with each other during both seasons (Table 4.3). However, the concentration of Zn is negatively correlated with the concentrations of Cu, Mn, and Pb. There was also strong positive correlation between the concentration of these heavy metals between wet and dry season except for Mn and Zn. However, the variation of heavy metal content in soil was well correlated to variation of soil content of heavy metals due to variation in the land uses and season. Slightly different trend was observed in vegetable samples. The concentration of Cu was correlated with that of Mn and Ni during both seasons. There was, however, strong positive correlation among the rest of the heavy metals assayed (Pb, Mn, Zn and Ni) during both seasons.

Table 4.3 Pearson Correlation coefficient (r) ofthe soil and vegetable

	Soil	Cu (wet)	Cu \(dry)	Pb (wet)	Pb (dry)	Mn (wet)	Mn (dry)	Zn(wet)	Zn(dry)	Ni(wet)	Ni (dry)
Soil	1.0000										
Cu (wet)	-0.7046	1.0000									
Cu (dry)	-0.5524	0.9689	1.0000								
Pb (wet)	-0.1165	0.7780	0.8915	1.0000							
Pb (dry)	-0.1240	0.7599	0.8915	0.9901	-1.0000						
Mn (wet)	-0.2232	0.7100	0.8569	0.8819	0.9382	1.0000					
Mn (dry)	-0.2182	0.7078	0.8555	0.8831	0.9392	1.0000	1.0000				
Zn (wet)	-0.2115	0.6587	0.5935	0.6249	0.5120	0.2181	0.2188	1.0000			
Zn (dry)	0.6831	-0.8572	-0.8935	-0.6780	-0.7346	-0.8597	-0.8570	-0.1917	1.0000		
Ni (wet)	0.2275	0.0923	0.3155	0.4649	0.5756	0.7577	0.7589	-0.3933	-0.4888	1.0000	
Ni (dry)	0.2878	0.1538	0.3869	0.5873	0.6803	0.8050	0.8069	-0.2404	-0.4795	0.9833	1.0000
	vegetable	Cu (dry)	Cu (wet)	Pb (dry)	Pb(wet)	Mn(dry)	Mn(wet)	Zn(dry)	Zn(wet)	Ni(dry)	Ni(wet)
Vegetables	1.0000										
Cu (dry)	0.3273	1.0000									
Cu(wet)	0.3796	0.9981	1.0000								
Pb (dry)	0.8922	0.4695	0.5021	1.0000							
Pb (wet)	0.8757	0.4507	0.4818	0.9990	1.0000						
Mn(dry)	0.9535	0.5252	0.5655	0.9752	0.9642	1.0000					
Mn(wet)	0.9535	0.5252	0.5655	0.9752	0.9642	1.0000	1.0000				
Zn (dry)	0.9839	0.3535	0.4086	0.8120	0.7883	0.9106	0.9106	1.0000			
Zn (wet)	0.9841	0.3544	0.4095	0.8129	0.7893	0.9113	0.9113	1.0000	1.0000		
Ni (dry)	0.6925	0.6276	0.6407	0.9372	0.9430	0.8726	0.8726	0.5930	0.5943	1.0000	
Ni (wet)	0.6973	0.6372	0.6506	0.9381	0.9432	0.8767	0.8767	0.6001	0.6015	0.9999	1.0000

Concentration of heavy metals in water

The results of analysis of concentrations of heavy metals in water samples were presented in Table 4.4. The concentration of Pb was 0.001 mg/L in upperstream (control) and 79.8 mg/L in midstream during wet season. During dry season, its concentration decreased in upstream, whereas it increased in middle stream. The concentration of Mn was 0.03 mg/L in upper stream and 5.9 mg/L in middle stream during wet season. During dry season, its concentration decreased in both upper stream and middle stream although it was still higher in middle stream. The highest concentration was recorded for Pb in middle stream during both seasons while the lowest concentration was recorded for Cu during wet season and for Zn during dry season. In general, the concentration of these heavy metals in Sabata river decreased in the order of Pb>Mn>Ni>Cu>Zn.

Pearson correlation coefficients

The results of Pearson's correlation analysis revealed that the occurrence of the five heavy metals assayed in water samples analyzed was strongly positively correlated with one another as show in Table 4.4. The correlation coefficients among the heavy metals analyzed ranges from 0.8938 to 0.9966 suggesting the possible pollution of the water by these metals from common source i.e. industrial wastewater. Moreover, there was correlation in the amount of these heavy metals in water samples between dry and wet seasons except for Cu.

Table 4.4 Heavy metal content in Sabata River

	Measured values (Mg/L)						**Permissible limit**		
Parameter	Upstream (control)		Middle stream (start industry)		Down Stream (irrigated)		WHO, 2003	WHO, 2010	USEPA
	Wet	Dry	Wet	Dry	Wet	Dry			
Cu	0.001	.002	2.210	3.200	1.390	1.400		0.10	1.30
Pb	0.001	0.005	79.800	75.300	38.200	36.200	0.010	0.01	0.015
Zn	0.054	0.055	0.580	0.600	0.400	0.380		0.2	
Mn	0.030	0.020	5.900	5.100	4.500	4.200		0.5	0.05
Ni	0.003	0.002	4.700	4.500	3.500	3.480	0.100	0.10	0.10
Person Correlation coefficient (r) of the water									
Water	Cu	Pb	Mn	Ni	Zn	Sample	Season		
Cu	1.0000								
Pb	0.9560	1.0000							
Mn	0.8938	0.9392	1.0000						
Ni	0.9246	0.9511	0.9966	1.0000					
Zn	0.9661	0.9836	0.9766	0.9877	1.0000				
Sample	0.1162	-0.0014	-0.3202	-0.2593	-0.1096	1.0000			
Season	0.4747	0.6102	0.7244	0.6806	0.6375	-0.5119	1.0000		

Results of Principal Component Analysis

The results of principal component analysis showed that nine of the variables in water were strongly correlated (Table 4.5). It showed increasing trend with middle stream in dry, downstream in dry, downstream in wet, middle stream in dry, upstream in dry, and upstream in dry seasons suggesting simultaneous variation of the nine criteria. Furthermore, it showed strong correlation for Mn in wet and dry seasons in water. In fact, the correlation of 0.969 that this principal component is primarily a measure of the middle stream in dry season in the water. The second principal component increases with upstream in wet and dry seasons. This component can be viewed as a measure of how the level of heavy metals varies in upstream in wet and dry seasons.

The first principal component was also strongly correlated with 9 of the original variables in vegetables (Table 4.5). The first principal component increases with increasing Cu in dry ,Cu in wet, Pb in dry, Pb in wet, Mn in dry, Mn in wet, Zn in dry, Zn in wet, Ni in dry, and Ni in wet seasons in the vegetables. This suggests that these 9 criteria vary together. This component can be viewed as a measure of the quantity of Cu in dry ,Cu in wet, Pb in dry, Pb in wet, Mn in dry, Mn in wet, Zn in dry, Zn in wet, Ni in dry, and Ni in wet seasons in the vegetables. Furthermore, the first principal component correlates most strongly with the Mn in dry and Mn in wet in the vegetables. In fact, the correlation of 0.994 that this principal component is primarily a measure of the Mn in wet and dry season in the vegetable.

The first principal component is strongly correlated with 9 of the original variables in the soil. The first principal component increases with increasing Mn in wet,Mn in dry, Pb in dry, Cu in dry, Pb in wet, Zn in dry, Cu in wet, Ni in wet, and Ni in dry seasons. This component can be viewed as a measure of the quantity of Mn in wet, Mn in dry, Pb in dry, Cu in dry, Pb in wet, Zn in dry, Cu in wet, Ni in wet, and Ni in dry seasons in the soil. Furthermore, the first principal component correlates most strongly with the Mn in wet and dry seasons in the soil. In fact, the correlation of 0.976 that this principal component is primarily a measure of the Mn in wet season in the soil. The second principal component increases with Ni in wet and dry seasons, Zn in wet and Cu in wet season. This component can be viewed as a measure of how a heavy metals level of Ni is in terms of available in soil. The third principal component increases with increasing Zn in wet season.

Table 4.5: Results from PCA of soil, water, and vegetables

Component Matrix				Component Matrix			Component Matrix		
	Component				1	2	Water	1	2
Soil	1	2	3	vegetable	.919	-.364	Middle stream dry	.969	.238
Mn Wet	.976	.212	-.043	Cu dry	.607	.747	Downstream dry	.968	.228
Mn Dry	.976	.215	-.039	Cu wet	.643	.705	Downstream wet	.967	.232
Pb Dry	.962	.051	.269	Pb dry	.973	-.084	Middle stream wet	.966	.246
Cu Dry	.947	-.321	-.010	Pb wet	.963	-.085	Parameter	-.386	-.064
Pb Wet	.930	-.046	.366	Mn dry	.994	-.107	Upstream dry	-.543	.833
Zn Dry	-.892	.140	.430	Mn wet	.994	-.107	Upstream wet	-.630	.771
Cu Wet	.840	-.537	-.076	Zn dry	.875	-.357			
Ni Wet	.599	.787	-.151	Zn wet	.876	-.356			
Ni Dry	.663	.749	.016	Ni dry	.905	.234			
Zn Wet	.399	-.688	.606	Ni wet	.910	.238			
Land use	-.347	.677	.649						

Bioconcentration factor (BCF)

The results of analysis of the bioconcentration factor for the heavy metals assayed are presented in Table 4.6. The results revealed that the highest BCF value was recorded for Pb in red beet during both seasons. Intermediate value was recorded for Pb in cabbage cultivated on irrigated farmland during both seasons. The lowest value was recorded for Pb in garden cabbage grown on rain-fed farmland during both seasons. The BCF value for Pb was higher than that of Cu during both seasons in the samples analyzed.

Table 4.6 The bioconcentration factor

parameter	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Cu	CB/IR	CB/IR	LU/IR	LU/IR	RB/IR	RB/IR	GC/RF	GC/RF
	0.32	0.31	1.15	1.10	0.4	0.38	0.52	0.53
	CB/WT	CB/WT	LU/WT	LU/WT	RB/WT	RB/WT		
	0.31	0.41	1.49	1.49	0.52	0.51		
	CB/FT	CB/FT	LU/FT	LU/FT	RB/FT	RB/FT		
	0.34	0.36	1.23	1.31	0.43	0.45		
Pb	CB/IR	CB/IR	LU/IR	LU/IR	RB/IR	RB/IR	GC/RF	GC/RF
	0.41	0.39	0.52	0.48	0.53	0.50	0.22	0.22
	CB/WT	CB/WT	LU/WT	LU/WT	RB/WT	RB/WT		
	0.62	0.51	0.67	0.62	0.63	0.63		
	CB/FT	CB/FT	LU/FT	LU/FT	RB/FT	RB/FT		
	0.53	0.57	0.68	0.69	0.70	0.71		
Contaminated Cu in wet season (CB +LU +RB/ IR +WT +FT)							0.69	
Contaminated Cu in dry season (CB +LU +RB /IR +WT +FT)							-	0.72
Control Cu in wet season (GC/RF)							0.52	
Control Cu in dry season (GC/RF)							-	0.43
Contaminated Pb in wet season (CB +LU +RB /IR +WT +FT)							4.30	
Contaminated Pb in dry season (CB +LU +RB /IR +WT +FT)								0.55
Control Cu in wet season (GC/RF)							0.22	
Control Cu in Dry season (GC/RF)								0.22

N.B: Cu- copper, Pb- lead, CB-Cabbage, LU-Lettuce, GC-Garden Cabbage, RB- Red beet root, IR-Irrigated, WT-Wetland, FT-Forest land, RF-Rain fed Farmland

Daily Intake of Metals (DIM)

The DIM represents the concentrations of heavy metals in vegetables, the conversion factor, and the daily intake of vegetables, and the average body weight, respectively. The DIM of Cu and Pb were 78.85 and 9.63, respectively. Table 4.7 presents the results of analysis of the DIM of Cu, Mn, Ni, Zn, and Pb in vegetable samples

Table 4.7 DIM of heavy metals

Metal	Season	Human	Cabbage	Lettuce	Red beet	Garden Cabbage
			DIM	DIM	DIM	DIM
Cu	WE	Adult	0.0003	0.0008	0.0004	0.0003
	WE	Child	0.0003	0.0013	0.0004	0.0003
	DR	Adult	0.0003	0.0012	0.0004	0.00027
	DR	Child	0.003	0.0013	0.0004	0.0003
Pb	WE	Adult	0.003	0.0041	0.0042	0.0011
	WE	Child	0.004	0.005	0.005	0.0012
	DR	Adult	0.0034	0.0041	0.0042	0.0011
	DR	Child	0.0037	0.0044	0.0064	0.0012
Zn	WE	Adult	0.0002	0.0002	0.0002	0.0001
	WE	Child	0.0001	0.0002	0.0003	0.0001
	DR	Adult	0.00016	0.0002	0.0002	0.0001
	DR	Child	0.00017	0.0001	0.0002	0.00012
MN	WE	Adult	0.00049	0.0012	0.0015	0.0003
	WE	Child	0.00054	0.0017	0.002	0.0003
	DR	Adult	0.00048	0.0011	0.002	0.0002
	DR	Child	0.00053	0.0012	0.002	0.0002
Ni	WE	Adult	0.013	0.0156	0.012	0.001
	WE	Child	0.014	0.0183	0.013	0.001
	DR	Adult	0.0124	0.0163	0.011	0.001
	DR	Child	0.0201	0.018	0.012	0.001

Non-carcinogenic risks

The results of analysis of the Total Target Hazard Quotient (TTHQ) of non-carcinogens showed that a child who consumed lettuce and cabbage during dry season was at higher health risk due to high accumulation of Cu and Pb in the area (Table 4.8). Both children and adults can be exposed to health risks when consuming lettuce during dry season. The children were at health risks due to high accumulation of Ni in cabbage, lettuce, and redbeet in the area. In general, the non-carcinogenic risks resulting from consumption vegetables was in the order of lettuce >red beet > cabbage > garden cabbage in the area. Besides, the concentration of heavy metals in vegetables revealed in order of Pb >Ni >Cu.

Table 4.8.THQ of vegetable consumption in Sabata town

Metal	Season	Human	Cabbage	Lettuce	Red beet root	Garden cabbage
			THQ	THQ	THQ	THQ
Cu	WE	Adult	0.001	0.0001	0.001	0.066
	WE	Child	0.056	0.200	0.100	0.060
	DR	Adult	0.01	0.002	0.001	0.000
	DR	Child	0.056	2.12	0.100	0.064
Pb	WE	Adult	0.063	0.080	0.102	0.022
	WE	Child	0.400	0.072	0.104	0.073
	DR	Adult	0.065	7.889	1.940	0.050
	DR	Child	5.98	7.099	7.292	0.000
Zn	WE	Adult	0.000	0.000	1.930	0.000
	WE	Child	0.010	0.005	0.005	0.005
	DR	Adult	0.000	0.000	0.002	0.000
	DR	Child	0.010	0.010	0.003	0.002
Mn	WE	Adult	0.001	0.003	0.001	0.004
	WE	Child	0.104	0335	0.062	0.320
	DR	Adult	0.001	0.003	0.001	0.004
	DR	Child	0.103	0.003	0.062	0.322
Ni	WE	Adult	0.003	0.105	0.003	0.046
	WE	Child	4.55	5.85	4.121	0.23
	DR	Adult	0.108	0.050	0.003	0.044
	DR	Child	4.81	4.14	3.98	0.23
	TTHQ		16.332	27.6281	19.209	1.54

Generally, the results of TTHQ of non-carcinogenic risk depicted a child consuming lettuce and cabbage containing Cu and Pb; cabbage, lettuce, and red beet containing Ni; and both child and adult consuming lettuce in the dry season exposed to health risks. The non-carcinogenic risks were decreasing in vegetables in the order of lettuce > red beet > cabbage > garden cabbage. Additionally, THQ was 5.98 (cabbage) and 7.1 (lettuce) for Pb; 8 (lettuce) for adults and 2.2 (lettuce) for Cu and 7.3 (red beet) for Pb for children, which is greater than 1 suggesting that health risks for people consuming such vegetables in the area.

Discussion

The running water and vegetables destined for human consumption and soil samples on which vegetables grow are polluted with heavy metals released from industrial wastes. Explicitly, the high level of Mn in irrigated vegetables showed that the possibility of the health risks on humans in the area. The amount of heavy metals assayed were Mn>Ni>Pb>Cu>Zn in that order. This observation agrees with the reports of Adamu & Nganje (2010) in Bantu soil in Nigeria. Taking the land use types into consideration, the highest level of heavy metal concentration was observed in irrigated land while the lowest was recorded in garden areas.This shows that industrial wastewater discharged into the environment carry heavy metals and accumulates them in the soil. Hence, soils irrigated with such effluent serve as a source of pollution for plants grown in the area. The adverse effects of these heavy metals are not restricted to the study area since the vegetable supply chain in the process may have an adverse health impact on wider areas due to various market outlets. In consent to our observation, previous researchers from Nigeria reported a similar trend in the Bantu area. The adverse effects of heavy metal-laden industrial wastewater accumulated in the soil can extend to livestock grazing in the area. This may implicitly affect human wellbeing through direct loss of animal productivity and indirectly through the consumption of contaminated livestock products.

Highest concentration of Mn recorded in vegetables cultivated on irrigated farms followed by wetland and forest land during both seasons.The concentration of all heavy metals assayed surpassed the safe limit of WHO, USEPA, and EU in the treatment group during both seasons. This shows that vegetables and other food crops cultivated in these areas bear health risks to the community. Similarly, high concentration of Pb, Zn, and Cu above the reference level for agricultural soil was recently reported in Mojo area (Gebeyehu and Bayissa, 2020). This suggests that pollution of soil by industrial industrial wastewater is widespread in Ethiopia implying the absence of treatment of industrial wastewater and their open discharge. Studies in Pakistan also showed similar results where by the amount of Cu, Mn, Zn, Pb, and Ni was high in the soil affecting ecology of the area (Waseem. A. *et al.,* 2014). However, in contrary to our observation Ahmed M. and colleague (2019) reported that the concentration of Cu, Zn, and Pb in the soil was not above permissible levels in multi-industry zone in Bangladesh during both seasons.

The concentration of Cu, Pb, Ni, and Mn in Sabata River was within the permissible limit set by WHO and USEPA in the upper stream during both seasons. However, the concentration Zn was higher than this permissible limit during both seasons in the upper stream. In contrary, the concentration of Cu, Pb, Ni, Mn, and Zn surpassed the standard limit set by WHO and USEPA in middle and downstream during both seasons. This is clear indication of how the heavy metals can affect large area along the course of the river jeopardizing the health of humans and animals. A similar observation was reported in Bangladesh where the concentration of Cu, Zn, and Pb exceeds the permissible levels in water used for irrigation during both wet and dry seasons (Ahmed. M *et al*., 2019). In agreement to our findings, studies carried out in Ghana showed that the concentration of Mn and Ni was higher than amounts allowed for drinking water (Bempah ,C, Kofi &Ewusi,A, 2016). Studies from India also reported concentrations of heavy metals above permissible limits for irrigation water (Ghosh A. Kr.,*et al*., 2016). Waseem. A. *et al.* (2014) also reported similar amounts of Cu, Mn, Zn, Pb, and Ni in drinking water in Pakistan whereas lower concentration was recorded during wet season (Ahmed. M *et al.,* 2019).

Lettuces cultivated on irrigated soil contain highest concentration of Ni during both seasons followed by red beets and cabbage. The higher concentration of Pb was recorded in lettuce during both seasons followed by red beet. The heavy metal concentration in vegetables was decreasing in the order of Ni>Pb>Mn>Cu>Zn in the study area. The high concentration of the heavy metals in the vegetables destined for human consumption, which is greater than the international safe limit set by WHO and USEPA implies the threat posed on the health of the consumers. Previously, for instance, a high level of heavy metals was shown to cause gastrointestinal cancer and problem in reproductive health (Türkdoğan *et al*., 2003). A similar observation was made on vegetable grown around the Akaki River in central Ethiopia (Minbale, 2015). Elsewhere in Africa studies revealed similar observations specifically for Pb in cabbage and lettuce in Accra, Ghana (Lente *et al*., 2014). Likewise, the levels of Cu, Zn, and Pb concentration in the water, soil, and vegetables varied seasonally in Bangladesh (Ahmed *et al*., 2019). In agreement with our findings, their concentration was higher during the dry season and lower during the wet season. This could be ascribed to the diluting effect of rainwater. Zinc had the highest concentration in vegetables in Bangladesh (Ahmed, M *et al*., 2019)**.** These latter authors also demonstrated the higher concentration of Cu, Zn, and Pb in vegetables that exceeded permissible levels**.**In consent with our findings, the effect of these heavy metals on food chain was prevailed in Pakistan (Waseem. A. *et al.*, 2014); high amount of Pb was recorded in rice **(**Ihedioha J. N., *et al.* 2019); relatively high concentration of Zn exceeding the maximum residue limit in Nigeria (MRL) (Li .J. *et al*., 2020); higher Ni in vegetables in Ghana (Bempah, C, Kofi &Ewusi,A., 2016), and higher Pb in roots and leaves of wheat above the phytotoxic limits in Egypt (Farahat E.A., *et al*., 2017) have been reported.

The high heavy metal concentration of lettuce prevailed in the Atebella area of Sabata town that resulted from pumping and using of untreated toxic wastes from the upper stream to lower stream Atebella vegetable irrigation farm area. Likewise, the Little Akaki River was more polluted by industries than big rivers are evidence for a high concentration of Pb in lettuce and Swiss chard in Kera and Peacock Farm (Fisseha, 2002; AARDP, 2017), however, all these vegetables not reached phytotoxic levels (AARDP, 2017). A similar observation was made for the concentration of lettuce grown in Kera and Peacock were contained a high amount of Mn (Fisseha, 2002) and the highest concentration of Cu, Ni, Pb, and Zn in Swiss chard (Fisseha,1998). In compliance with our observation, the Cu, Ni, and Zn in potato were surpassed the standard limit set by WHO in the Addis Ababa city farm area (Fisseha, 1998; AARDP, 2017).

The translocation of heavy metal from soil to vegetable was analyzed using BCF. The highest BCF value prevailed in Cu lettuce of the irrigated area during the wet and dry season ranges from 1.10-1.49 mg/L in Sabata town. Especially, the highest BCF value of the treatment group was reported in the lettuce in the irrigated area in the dry season than the wet season. On the contrary, the highest BCF value of control group value was registered in Cu in the garden cabbage (0.52) in the wet and dry seasons, which signifies that the vegetable is not influenced by the concentration of Cu. The results clearly show that the BCF of Cu in lettuce is greater than the acceptable value of 1. This agrees to some extent with the reports of Jolly *et al.*, (2013) from the Ruppur area of Bangladesh. The BCF value was decreasing the order of Zn>Cu>Pb in Daye City of China (Yang *et al.*, 2017). Similarly, BCF of heavy metals were significantly higher for vegetables grown in the Sanso soils in Ghana (Bempah,C, Kofi &Ewusi ,A., 2016).

The BCF of Cu was also shown to be significant in Addis Ababa city vegetable farm (Prabu *et al*., 2011; AARDP, 2017), which complies with the current study of the BCF value of Cu. The BCF value of Sabata town was found to be quite similar in Pb concentration in Punjab India (Bhatti *et al*., 2016).In contrast to the current study, BCF value was decreasing in the order of Ni>Pb in the city of Kaduna of Nigeria (O. Jacob & E. Kakulu, 2012). The difference might be due to differences in the type of the industry, which affects the types of inputs and point sources of wastes. For instance, in Bangladesh, the discharged wastes were urban waste rather than industrial wastes. The results, however, showed the health risk associated with the intake of leafy vegetables containing Cu in the study areas.

The intake of heavy metal-containing vegetables is known to bear human health risks (Pendias and Pindias 1984; AARDP, 2017) and results in complications of reproductive health especially in pregnant women (AARDP, 2017). The HRI value showed a health risk exposure for child consuming cabbage containing a Pb in the wet season and both child and adult consuming lettuce and red beet are containing Pb in wet and dry seasons in the study area. The child consuming a cabbage in a dry season containing Ni may expose to health risks in the area. The HRI value of garden cabbage vegetables were less than one signifying no exposure to health risk for both child and adult in the area. The present HRI study was almost consistent with the findings of Fisseha (2002) who studied trace metals such as Ni and Pb in vegetables in Central Ethiopia. In contrast, Lente *et al.* (2014) reported that the vegetables tested in Accra of Ghana had no health risk although the concentration of Pb in vegetables was above the safe limit of FAO/WHO. The hazard index (HI) values were more than 1 for local fishermen, suggesting that local fishermen may be experiencing some adverse health effects in China (Zhu. F.*et al.,* 2015). The hazard index for vegetables was higher than 1, indicating high health risk due to heavy metals contamination through consumption of vegetables grown around the sampling sites.

The THQ was decreasing in the order of Pb >Ni >Cu >Mn in the Sabata town of Ethiopia. Likewise, the THQ was decreasing in the order of Cd> Mn> Zn> Pb> Cu>Fe>Ni>Co>Cr in the Ruppur area of Pabna District of Bangladesh and Kunshan of China as Pb>Cd>Ni>Co>Cr (Jolly et al., 2013). Furthermore, the non-carcinogenic risk was higher in the child than an adult in Sabata town. This might be children evaluates to adults was owing to lower body weight assumptions in the calculation (Ishak *et al.,* 2016). Similarly, the HRI in the Daye City of China showed the carcinogenic risk was higher in children than adults, while the non-carcinogenic risk was higher in adults than children (Yang *et al.,* 2017).The THQ (>1) for non-carcinogenic risk for Pb in leaves, fruits, and root vegetables indicates potential health risk exposure in humans in Satkhira of Bangladesh (Uddin et al. 2019). The THQ (<1) was no health risk consuming Cockles in Kuala Selangor (Ishak *et al.,* 2016). Higher HQ value for Mn and Zn may not pose risk to human health since they are essential elements for humans (Jolly *et al.,* 2013).Similarly, the THQ and Total THQs of all metals were showing remarkable non-carcinogenic health hazards for adult population through consumption of all crops and vegetables of Mokesh Beel in Bangladesh (Ahmed *et al.*,2019).

In agreement with present studies, estimated average daily intake and hazard quotient for Pb in vegetable samples exceeded permissible limit in Ghana (Bempah, C, Kofi & Ewusi, A., 2016). Similarly, health risks was exposed consumption vegetables grown on wastewater analyzed for Pb in Ghana (Bempah, C, Kofi & Ewusi,A., 2016), Pb in polluted site for crops greatest potential to pose health risk at South Cairo, Egypt (Farahat E.A., *et al*. 2017), the TTHQ values (1.627) of beyond 1 were found in Wild fish caught by anglers (WFAs) indicating that children are being prone to serious health risks owing to the consumption of this fish in China (Li . J. *et al.*, 2020), THQ found >1 for As, Hg and Co due to cabbage in Mojo consumption, suggesting significant health risk (Gebeyehu and Bayissa, 2020), the toxicity induced by contaminated water, soil, and vegetables poses serious threat to human health in Pakistan (Waseem. A. *et al*. 2014), *Cyprinus carpiohad* fish species had the highest HQ and HI in China (Zhu. F. *et al.*, 2015), and Pb investigated in fish samples higher relative contributions to the HI values in china (Zhu.F. *et al*, 2015). In contrast, individual heavy metal hazard quotient (HQ) values were not greater than 1 and no exposure of health risk through fish consumption (Zhu. F. *et al.,* 2015), consumption of vegetables grown with use of treated industrial wastewater from peri-urban vegetable growing areas of Northern India (Varanasi) indicated that all the vegetables were safe for human consumption (Ghosh A. Kr., *et al.* 2016), and hazard quotient and the total hazard index were less than one showing that no possible adverse health effect on rice consumers in Nigeria (Ihedioha J. N., *et al.*, 2019).

Conclusion

The establishment of manufacturing industries is inevitable for developing countries where there is fast economic growth. However, there should be optimal waste management strategies to safeguard the environment, animals, and humans from adverse effects. To this end, the survey results revealed that the environment and human health is under threat from untreated industrial wastes discharge in Sabata town of Central Ethiopia. This study depicted that the concentration of heavy metals (Cu, Pb, Ni, Mn, and Zn) was above the safe limit set by WHO and USEPA in the middle stream and downstream of the Sabata River during dry and wet seasons. The concentration of Pb was higher than the safe limit enacted by USEPA in soil collected from irrigated land, forest area, and wetland. Similarly, the level of Pb was higher than the safe limit of WHO/FAO in red beet grown on irrigated Atebella farm in the wet season. The levels of heavy metal decreased in the order of Pb>Mn>Ni>Cu>Zn; Mn>Ni>Pb>Cu>Zn, and Ni>Pb>Mn>Cu>Zn in the Sabata river, soil, and vegetable samples in the area, respectively. The concentration of heavy metal was varying in water, soil, and vegetable because of the heavy metal speciation and valence, industry types, the difference in biodegradability, vegetable types and tissues, and others. The bioconcentration factor value of Cu was above one in lettuce in both wet and dry seasons.

Furthermore, Ethiopia has not implemented a maximum permissible safe limit for the levels of heavy metals of industry wastewater release into water bodies (rivers or streams), soil, and vegetables. Industrial wastewater from such industries have not managed in a systematic way of waste treatment technologies. To tackle the adverse impact of the toxic industrial wastes, an integrated and area-specific approach of industrial waste management was required for effective and efficient industries waste management. Thus, the government has to devise mitigation strategies through the implementation of heavy metal removal systems from contaminated river water and soil, waste management strategies of recycling, centralized or decentralized treatment plant, changing of industrial residual into biogas production, and awareness creation for the society.

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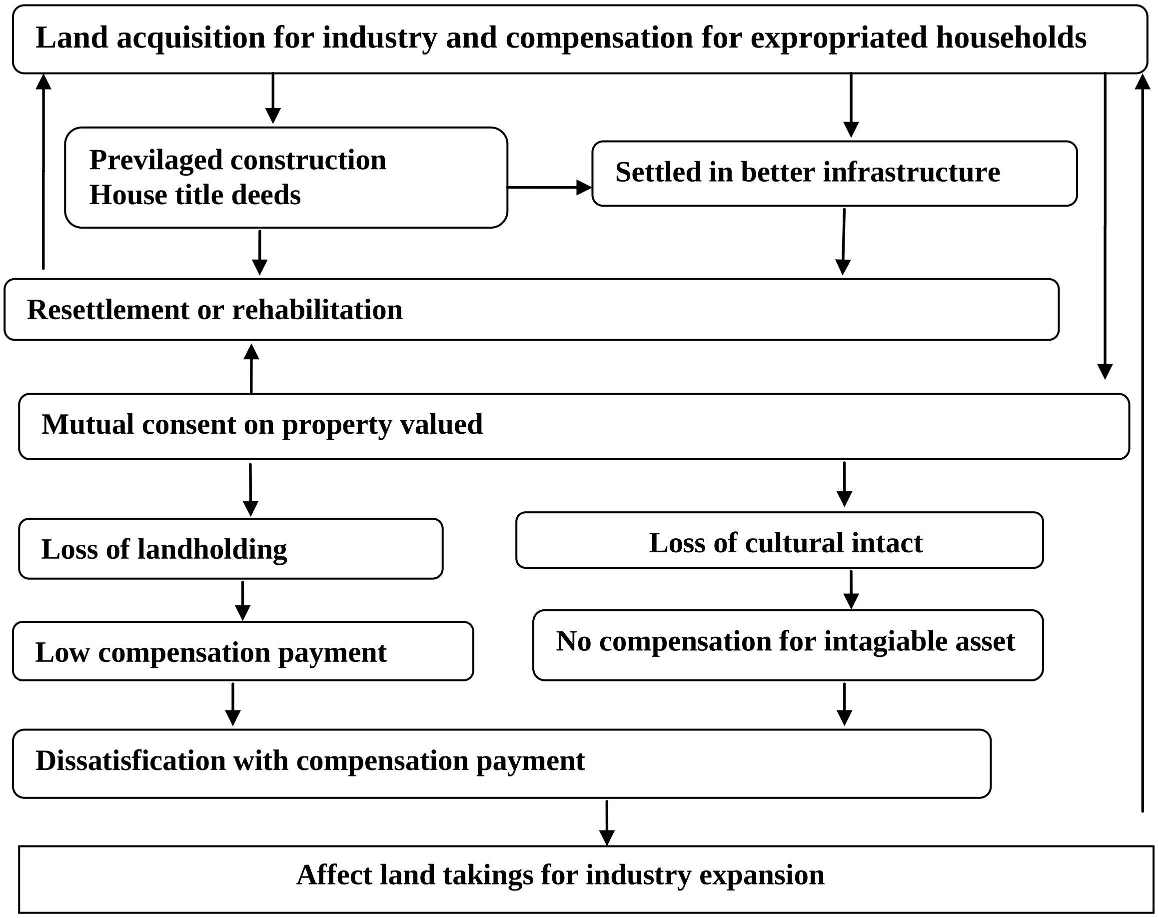
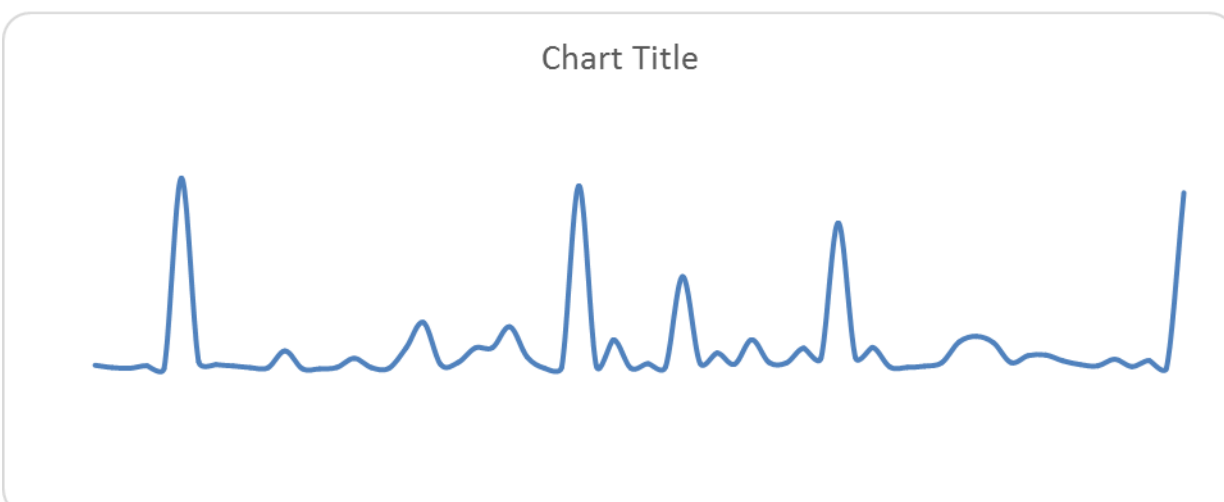
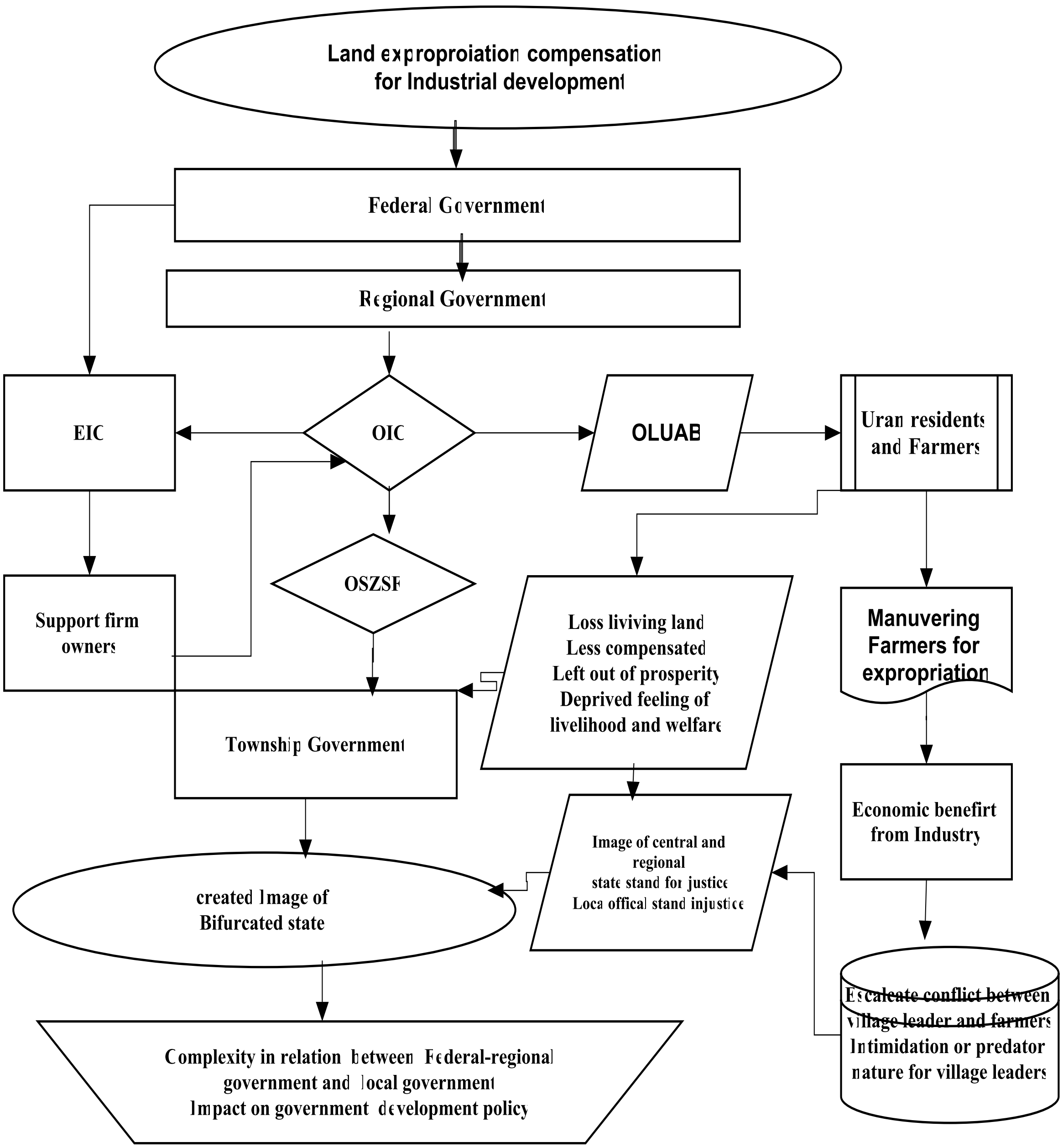
Annex



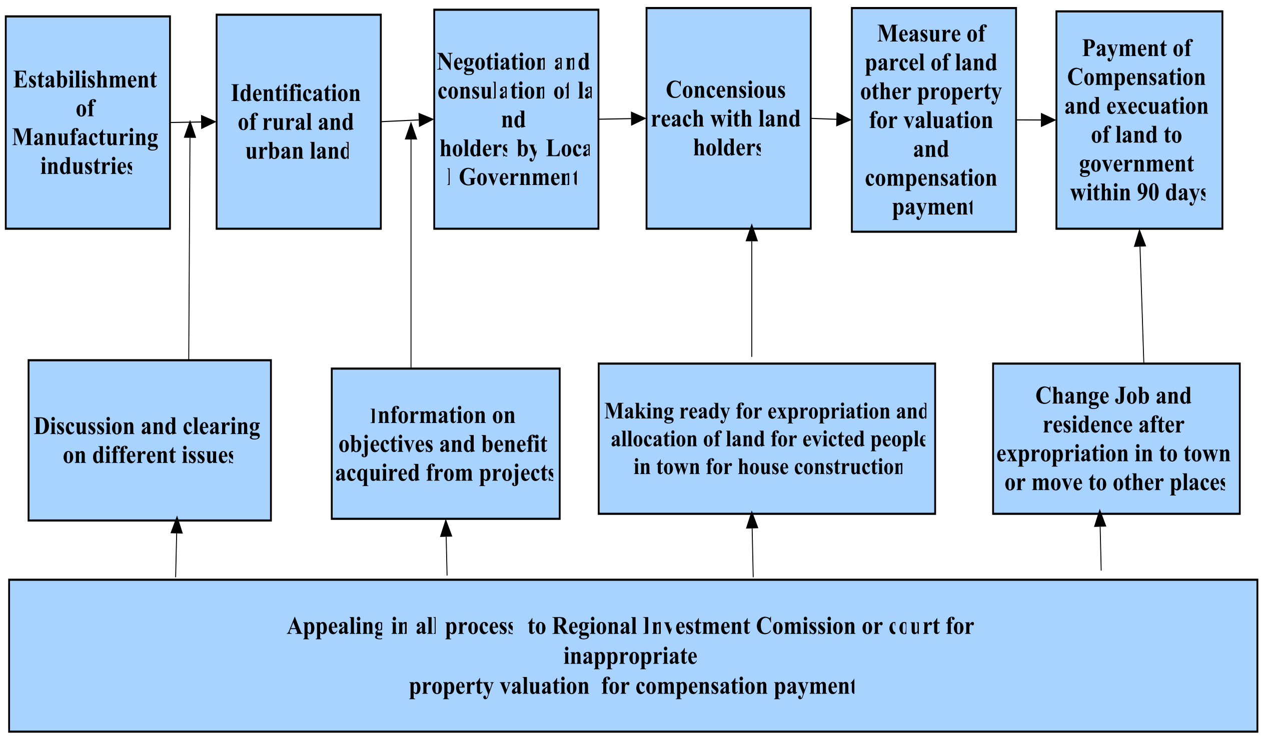
Annex 1.1Effectsof industry expansion on means of living of expropriated households



Annex 1.2 The Land allocated for manufacturing industries (1992 to 2019)



Annex 1.3 The governance strcture of land acquisition



Annex 1.4 Land Acquisition process

Paper II

Annex 2.1 Number of family of per household as disclosed by the respondent

No. family	Number Female HH size		Number of Male HH size	
	No	Percent	No	Percent
0	6	1.3	15	3.3
1	124	27.6	105	23.4
2	141	31.4	131	29.2
3	63	14.0	104	23.2
4	62	13.8	52	11.6
5	22	4.9	16	3.6
6	25	5.6	5	1.1
7	4	0.9	11	2.4
8	1	0.2	8	1.8
9	1	0.2	1	0.2
10	0	0	1	0.2

Annex 2.2 Percentages distributions of respondents by administrative unit and landholding size in hectares (N=449)

Type of resident	**Obs**	**Administrative unit**															
		Sabata		**Alamgena**		**Walate**		**Furi**		**Dima**		**Dalati**		**Roge**		**Karabu**	
		No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Non expropriated	244	66	15	39	9	45	10	44	9.7	24	5.3	11	2.4	8	1.7	7	1.5
Expropriated	205	50	11	27	6	54	12	40	8.9	18	4	8	1.7	6	1.3	2	0.5
Total	449	116	26	66	15	99	22	84	18.6	42	9.3	19	4.1	14	3.1	9	1.5
Land holding in		landless				0.01-0.5		0.51-1		1.51-2			2.01 and	above			
hectare		**No**		**%**		**No**	**%**	**No**	**%**	**No**	**%**		**No**		**%**		
Non expropriated	244	0		0		177	39	30	7	20	4.6		17		3.8		
Expropriated	205	13		2.89		185	41	5	1.1	2	0.45		0		0		
Total	449	13		2.89		362	80	35	8.1	22	4.51		17		3.8		
Wealth status	**Very poor**	**poor**	**middle**	**Better off**		**Becho-Adea teff and chickpea Livelihood Zone (LZ) in 2017**											
Land size owned (Ha)	0.5	1	2	3													

Annex 2.3 Percentages distributions of respondents by sex of households head (N=449)

Type of resident	Obs.	Sex of households head			
		Male		Female	
		No	%	No	%
Non-Expropriated	244	183	41	61	14
Expropriated	205	156	35	49	11
Total	449	339	75	110	25

Annex 2.4 Percentages distributions of respondents by religion and number of households size (N=449)

Type of resident	Obs	**Type of religion**							
		Orthodox Christian		**Muslim**		**Protestant Christian**		**Wakefata**	
		No	%	No	%	No	%	No	%
Non expropriated	244	156	35	3	0.7	73	16.3	12	2.7
Expropriated	205	142	32	43	1	12	2.7	8	1.8
Total	449	298	67	46	1.7	85	19	20	4.5

Annex 2.5 Percentage distribution of households's structure and level of education
Table 4.8: Percentages distributions of respondents by marital status of HH head (N=449)

Type of resident	**Obs.**	**Marital status**									
		Single		**Married**		**Divorced**		**Widow**		**Separated**	
		No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Non-expropriated	244	15	3.3	220	49	0	0	9	2	0	0
Expropriated	205	1	0.22	187	42	1	0.22	14	3.1	2	0.45
Total	449	16	3.25	407	91	1	0.22	23	5.1	2	0.45

Table 4.9 Percentages distributions of respondents by religion and number of households size (N=449)

Type of resident	Obs	**Type of religion**							
		Orthodox Christian		**Muslim**		**Protestant Christian**		**Wakefata**	
		No	%	No	%	No	%	No	%
Non expropriated	244	156	35	3	0.7	73	16.3	12	2.7
Expropriated	205	142	32	43	1	12	2.7	8	1.8
Total	449	298	67	46	1.7	85	19	20	4.5

Table 4.10 Percentage distribution of households's structure and level of education

Year of Reside	Non-Expropriated		Expropriated		Age of households head (year)	Non expropriated		Expropriated	
	No	%	No	%		No	%	No	%
<1	0	0	0	0	Less 18	7	2.9	0	0
2-5	14	5.7	2	0.9	18-25	19	7.8	4	1.9
6-10	15	6	2	0.9	25-33	41	17	22	10.7
11-15	9	3.7	23	11	34-41	25	10	18	8.8
16-25	45	18	82	40	42-50	38	16	28	13.7
Above 25	161	66	84	41	51-59	48	20	40	19.5
No. of dependent in households head					Above 60	60	24.5	75	36.6
					Level of education of households head				
0	7	2.9	8	3.9	No formal	53	21.7	43	21
1-3	197	80.7	185	90	Primary (1-6)	95	38.9	102	49.8
4-6	40	16.4	12	5.9	Junior (7-8)	12	4.9	18	8.8
Above 6	0	0	0	0	High school (9-12)	37	15.2	40	19.5
					University	45	18	11	5.4

Annex 2.6 Percentage distribution of Households by type of employment engaged

Type of Employment	Non-Expropriated		Expropriated	
	No	**%**	**No**	**%**
Trading	41	16.7	31	15
Own farm	75	30.6	24	11.7
Causal/wage empolyment	36	14.7	97	47
Pension	2	0.8	0	0
Salary work	7	2.9	3	1.5
others	10	4.1	15	7.2

Annex 2.7 Number of livestock own of householdss within each wealth group

Livestock own	Number	Wealth Category	Non expropriated		Expropriated	
			No	%	No	%
Average oxen	1	verypoor	19	7.8	18	8.7
	3	poor	36	14.7	187	91
	7	medium	187	76	0	0
	12	better-off	0	0	0	0
Average Sheep	3	verypoor	13	5.4	5	2.4
	5	poor	17	6.9	200	97.6
	10	medium	154	62.9	0	0
	16	better-off	0	0	0	0
Average Hens	Up to 1	verypoor	20	8.2	27	13.2
	1-3	poor	26	10.6	178	86.8
	3-7	medium	104	42	0	0
	Above 7	better-off	0	0	0	0
Average Donkeys	Up to 1	verypoor	2	0.8	29	14
	1-3	poor	2	0.8	176	85.8
	3-7	medium	241	98	0	0
	Above 7	better-off	0	0	0	0
Average Goats	Up to 3	Verypoor	30	12	38	18.5
	5	poor	40	16	167	81.5
	10	medium	175	71	0	0
	16	better-off	0	0	0	0
Livestock (TLU)	Wealth category				**Becho- Adea teff and chickpea (BAT) Livelihood Zone (LZ) in 2017**	
	verypoor	poor	middle	better off		
Oxen	0	1	2	3		
Goats	0	0	3	3		
Sheep (TLU)	2.5	3.5	4	6		
Cattle	1	2	5	7		
Donkey	1	1	2	3		
Hen	3	5	6	7		

Annex 2.8 Sources of income generation

Type of productive asset	Annual Income (ETB)	Non expropriated		Expropriated	
		No	%	No	%
Small business or sharecropping	10,000	0	0	202	98.5
	25400	242	99.2	3	1.5
	30000	3	0.8	0	0
	30,000	0	0	0	0
Goats/sheep sales	5000	0	0	202	98.5
	7000	2	0.8	0	0
	15000	242	98	3	1.5
	20000	0	0	0	0
Sale of hen and egg	2000	0	0	32	15.6
	2500	242	98	172	83.9
	3000	2	0.8	0	0
Milk/butter sales	9000	242	98	202	98.5
	12000	2		3	1.5
Wood or charcoal sale	Up to 5000	240	98	180	87.8
	20000	2	0.8	3	1.5
	30000	2	0.8	25	12.2
Cattle sale	17000	0	0	169	82
	19000	2		11	5.4
	22000	242	98	25	12.2
Pulses sale	5000	0	0	180	87.8
	10000	240	97.9	20	9.8
	15000	2	0.8	5	2.4
	20000	2	0.8	0	0
Sale of cereal crops	2000	2	0.8	28	13.7
	10000	0	0	152	74.1
	37000	0	0	25	12.2
	100000	242	98	0	0
Vegetable sale	0	0	0	180	87.8
	15000	2	0.8	0	0
	25400	242	98	3	1.5
	50000	0	0	22	10.7
Annual income per households		verypoor **8356-14448**	poor **12998-20557**	medium **25255-41650**	better off **37625-47395**

N.B. The categorization of wealth status of annual income per households was based on Becho-Adea teff and chickpea (BAT) Welfare zone (LZ), 2017

Annex 2.9 Percentage distribution of distance from social services

Distance from infrastructure facilities	Distance (M)	Non-expropriated		Expropriated	
		No	%	No	%
Distance from health center (M)	500	72	29.4	3	1.5
	1000	172	73.1	158	77.1
	1200	0	0	1	0.5
	2000	0	0	43	21
Distance from portable water (M)	0	2	0.8	1	0.4
	500	72	34	204	99.5
	1000	170	69.4	0	0
Distance from passable vehicle road (M)	300	40	16	201	98
	500	170	69.4	2	0.9
	1000	32	13	1	0.5
	1500	2	1.2	1	0.5
Distance from grain mill (M)	500	72	29.4	63	30.7
	550	7	2.9	0	0
	1000	170	69.4	142	69.3
Distance from market center (M)	1000	170	69.4	159	77.6
	1700	2	0.8	0	0
	2000	72	29.4	3	1.5
	2500	0	0	43	21

Annex 2.10 Percentage distribution of livestock and crop production of respondents

Livestock and crop production	Amount of asset	Wealth category	Non expropriated		Expropriated	
			No	%	No	%
Milk (lit)	Up to 58	Verypoor	15	6.1	176	85
	58-188	poor	5	2	12	5.0
	188-375	medium	21	8.6	0	0
	375 and above 563	better-off	199	81	0	0
Cereals crop (kg)	Up to 650	verypoor	13	5.3	91	44.4
	650-850	poor	17	6.9	91	44.4
	850-2450	medium	150	61	27	13.2
	2450 and above 4125	Better off	63	26	0	0
pulses (kg)	Up to 165	Verypoor	54	22	191	93
	165-600	poor	30	12	14	6.8
	600-1620	medium	6	2.4	0	0
	1620 and above 2210	better-off	148	60	0	0
Own food crop products meet annual need (yr)	50% (6 month)	verypoor	15	6.1	164	80
	55% (6 ½ month)	poor	52	21	41	20
	70 % (7-9 months)	medium	147	60	0	0
	80% (> 9 1/2 month)	Better off	26	10.6	0	0
Number of Oxen plow own	Rarely own	verypoor	26	11	110	53.7
	Own one pair with neighbor	poor	73	30	90	43.9
	Own requisite one pair (1-2 pair)	medium	139	56.7	4	1.9
	Own minimum pair or 4 plow animals	Better off	6	2.4	1	0.5

N.B. The wealth status was based on Becho-Adea teff and chickpea Welfare Zone, 2017

Table 1 Operational Manufacturing industries by Number, area, capital and job created (1991-2019)

Name of Kebeles	Year	No.	Area(ha)	Capital (ETB Million)	Job by sex	
					M	F
Sabata	1998	1	1.2	50	26	20
	1999	1	0.515	15	8	2
	2001	1	0.3	5	14	9
	2005	2	1.07	209	33	48
	2006	1	0.2	3	8	52
	Total	**6**	**57.5**	**812**	**604**	**309**
Alemgena	1998	1	2.2	400	111	132
	2000	1	1.4	200	392	110
	2002	1	1	7	34	12
	2003	1	0.5	3	10	20
	2005	2	0.44	227	72	52
	Total	**6**	**5.54**	**837**	**619**	**192**
Walate	1995	1	0.16	5	15	10
	2000	1	0.121	20	25	26
	2005	1	0.56	199	16	8
	Total	**3**	**3.3**	**224**	**56**	**44**
Furi	1992	1	0.48	8	8	2
	1994	1	0.28	3	33	20
	1995	10	6.4	162.2	590	447
	1996	16	14.1	803.5	830	702
	1997	4	1.44	46	134	97
	1998	4	2	35.2	41	25
	1999	13	6.4	121.02	199	164
	2000	17	6.5	165	1395	439
	2001	6	12.8	251.1	470	338
	2002	9	3.71	582.5	346	143
	2004	1	0.35	2.3	4	5
	2005	1	0.56	99	16	8
	Total	**83**	**55.14**	**2379**	**3219**	**2242**
Dima	1995	1	1.1	11	33	30
	1999	4	8.9	68	72	83
	2000	1	0.32	3	6	2
	2001	1	1.7	755.4	440	583
	2005	1	0.56	199	16	8
	Total	**8**	**27.9**	**1036.4**	**567**	**1603**
Dalati	1991	2	1.9	11	10	6

	1995	1	4.9	8	8	12
	1996	1	1.5	10	46	50
	1997	4	8.9	108	552	1105
	1998	2	2.043	13	17	40
	1999	6	1.89	460	266	325
	2000	5	6.38	46	72	173
	2005	3	3.3	289	232	212
	Total	**24**	**44**	**1056.9**	**618**	**2082**
Roge	1999	3	3.5	32	90	106
	2000	1	6.6	10	4	2
	2004	1	0.65	10	15	4
	2005	1	0.56	199	16	8
	2006	1	0.93	40	100	50
	2007	1	2	50	40	10
	Total	**8**	**8.22**	**341**	**265**	**181**
Karabu	1995	4	9.9	40.5	24	51
	1996	11	7.94	148.2	570	333
	1997	5	2	24.2	83	90
	1999	9	4.1	166	399	479
	2000	11	4.3	168	224	201
	2001	8	2.55	2846.3	3703	5219
	2002	2	1.4	36	40	45
	2003	1	1	28	25	30
	2004	1	3	12	13	77
	2005	2	0.81	207	21	26
	2006	3	2.61	44	48	7
	2007	2	0.42	14	14	19
	Total	**59**	**53.1**	**3543**	**5199**	**6606**

Table 1. Percentages distributions of land acquisition by type of manufacturing industries owner and legal business ownership (N=205)

Type of manufacturing industries owner									
Foreign			Domestic		Joint Venture		Others		
Fre		%	Fre	%	Fre	%	Fre.	%	
164		74	36	16.3	10	4.5	11	4.9	
Type of legal Business ownership									
Private limited company		partnership		Sole proprietorship		Share company		Cooperatives	
Fre	%	Fre	%	Fre	%	Fre	%	Fre	%
180	84	1	0.5	30	14	2	0.9	2	0.9

NB Fre-Frequency.

Table 2. Percentages distributions of respondents' land acquisition by type of manufacturing industrial owners (N=205)

Type of resident	Obs.	Type of manufacturing industries															
		Brewers and alcohol		leather		textile		metal		food		paper		construction		others	
		No	%	No	%	No	%	No.	%	No.	%	No	%	No	%	No	%
Expropriated	205	36	18	1	0.5	43	21	16	8	43	21	11	5.4	23	11	32	16

Summary of land laws in Ethiopian constitution of 1995

Regulation and policies	Description
1. Constitution of the FDRE, Proclamation No. 1/1995	
Article 40(3)	Rural and urban land ownership vested on State and in the peoples of Ethiopia
Article 40(4)	Peasants right to obtain land without payment and the protection against eviction from their possession.
Article 40(5)	Pastoralists right not to be displaced from their own lands.
Article 40(6)	Government ensure the right of private investors to the use of land
Article 40(7)	the full right to the immovable property
Article 40(8)	government may expropriate private property for public purposes subject to payment in advance of compensation commensurate
Article 52 (2)(d)	regional states "to administer land and other natural resources
Article 89	On behalf of people, government has the duty to hold land for common benefit and development
Article 97 (2)	States shall determine and collect fees for land user rights
Article 51(5)	the Federal powers in land administration
2. Proclamation No. 456/2005 FDRE Rural Land Administration and Land Use	
Rural land	Any land outside of a municipality holding or a town
A holding right	right any peasant farmer or semi-pastoralist and pastoralist to use rural land for different purposes
Acquisition and use of rural land	Peasant farmers/pastoralists, who is 18 years of age or Above, children who lost their mothers and fathers, Private investors, governmental, NGO and social and economic institutions
Investor	leased rural land may present his use right as collateral
3. Proc. No.455/2005 Expropriation of Land Holdings for Public Purpose and Payment of Compensation	
compensation payment 2(1)	made in cash or in kind or in both to a person for his property situated on his expropriated landholding."
public purpose 2(5)	the use of land in order to ensure the interest of the peoples to acquire

	direct or indirect benefits from the use of the land and to consolidate sustainable socio-economic development”
landholder 2(3)	an individual, government or private organization or any other organ which has legal personality and has lawful possession over the land to be expropriated and owns property, situated thereon
3.1 Land Acquisition for expropriation of rural and urban	
Woreda or urban administration Art. 2(4)	to expropriate a landholding notify the landholder in writing the time when to be vacated and the amount of compensation to be paid.
2(4) Sub-Art. (1)	vacated may not, in any way, be less than ninety days.
2(4) Sub-Article (1)	hand over the land to the woreda or urban administration within 90 days from the date of payment of compensation
2(4) Sub-Article (1)	if he refuses to take compensation, the compensation in a blocked bank account in the name of the woreda or urban administration
2(4) Sub-Article (3)	If there is no crop, perennial crop or other property on the expropriated land, woreda or urban administration within 30 days
2(4) Sub-Article (3) of (4)	If expropriated order refuses to handover the land, the woreda or urban administration may use the police force to take over the land
Compensation payment Section 3(7)	compensation for property on the land and permanent improvements made on land
Section 3(7) amount of compensation	determined based on the replacement cost of the property.
Section 3(8) displacement compensation	equivalent to ten times the average annual income he secured during the five years preceding the expropriation of the land.
Article 7	be paid until repossession of the land, compensation for lost income based on the average annual income secured during the five years preceding the expropriation of the land; however, t such payment does not exceed the amount of compensation payable under Sub-Article (1)
Woreda Administration Sub-Articles (1) and (2)	confirms that substitute land which can easily ploughed and generate comparable income is available for the land holder, the compensation

	to be paid
Section 3, No.8 (11) (1) of the expropriation	rural areas and in an urban center where an administrative organ to hear grievances related to urban landholding is not yet established, to the regular court having jurisdiction
Section 3, No.8 (11) (2) of the expropriation	Where the holder of an expropriated urban landholding is dissatisfied with the amount of compensation, he may lodge his complaint to the administrative organ
Section 3, No.8 (11) (4)	expropriation proclamation 2005 states "A party dissatisfied with a decision, Sub-Article (I) and (3) of this Article may appeal, to the regular appellate court or municipal appellate court within 30 days from the date of the decision. The decision of the court shall be final
4. Proc. No. 721/2011Lease holding of Urban Lands	
Article 40 of the constitution	land is the property of the state and the people of Ethiopia
Part Two of section 5(1)	no person may acquire urban land other than [through] the lease holding system
Part Three, section 18(1)	The period of urban land lease shall vary depending on the level of urban development and sector of development activities
A lease	a system of land tenure by which the right of use of urban land is acquired under a contract for a definite period"
Public interest	The use of land defined by the decision of the appropriate body in conformity with an urban plan to ensure the interest benefits from the use of the land and to consolidate sustainable socio-economic development"
Manufacturing industry premises	plots of land reserved, developed or allotted based on land use plan for use of manufacturing industry
An urban center	any locality having a municipal administration or population size of 2000 or more inhabitants of which at least 50% of its labour force is engaged in non-agricultural activities"

Source: Adapted from Berhanu WoldeGiyorgis, ND

- East Oromia Branch(Adama)-Arsi Zone, East and West Hararghe Zone, East Shewa Zone (including Bishoftu, Mojo & other towns)
- Central Oromia Branch(Dukem)-West Shewa Zone, North Shewa Zone, South West Shewa Zone, & Oromia Special Zone Surrounding Finfine (OSZSF)
- South West Oromia Branch(Jimma)-Jimma Zone, Iluaba bor Zone, & Buno Bedele Zone
- West Oromia Branch(Nekemte)- West Wallega Zone, East Wallega Zone, Kellam Wallega and Horro Guduru Wallega Zone
- South Oromia Branch- Borena Zone, Gujii Zone, West Gujii and West Arsi zone.

Table 1. Operational Manufacturing industries by Number, area, capital, and job created (1991-2019)

Name of Kebeles	**Year**	**No.**	**Area(ha)**	**Capital (ETB Million)**	**Job by sex**	
					M	F
Sabata	1998	1	1.2	50	26	20
	1999	1	0.515	15	8	2
	2001	1	0.3	5	14	9
	2005	2	1.07	209	33	48
	2006	1	0.2	3	8	52
	Total	**6**	**57.5**	**812**	**604**	**309**
Alemgena	1998	1	2.2	400	111	132
	2000	1	1.4	200	392	110
	2002	1	1	7	34	12
	2003	1	0.5	3	10	20
	2005	2	0.44	227	72	52
	Total	**6**	**5.54**	**837**	**619**	**192**
Walate	1995	1	0.16	5	15	10
	2000	1	0.121	20	25	26
	2005	1	0.56	199	16	8
	Total	**3**	**3.3**	**224**	**56**	**44**
Furi	1992	1	0.48	8	8	2
	1994	1	0.28	3	33	20
	1995	10	6.4	162.2	590	447
	1996	16	14.1	803.5	830	702
	1997	4	1.44	46	134	97
	1998	4	2	35.2	41	25
	1999	13	6.4	121.02	199	164
	2000	17	6.5	165	1395	439
	2001	6	12.8	251.1	470	338
	2002	9	3.71	582.5	346	143
	2004	1	0.35	2.3	4	5

	2005	1	0.56	99	16	8
	Total	**83**	**55.14**	**2379**	**3219**	**2242**
Dima	1995	1	1.1	11	33	30
	1999	4	8.9	68	72	83
	2000	1	0.32	3	6	2
	2001	1	1.7	755.4	440	583
	2005	1	0.56	199	16	8
	Total	**8**	**27.9**	**1036.4**	**567**	**1603**
Dalati	1991	2	1.9	11	10	6
	1995	1	4.9	8	8	12
	1996	1	1.5	10	46	50
	1997	4	8.9	108	552	1105
	1998	2	2.043	13	17	40
	1999	6	1.89	460	266	325
	2000	5	6.38	46	72	173
	2005	3	3.3	289	232	212
	Total	**24**	**44**	**1056.9**	**618**	**2082**
Roge	1999	3	3.5	32	90	106
	2000	1	6.6	10	4	2
	2004	1	0.65	10	15	4
	2005	1	0.56	199	16	8
	2006	1	0.93	40	100	50
	2007	1	2	50	40	10
	Total	**8**	**8.22**	**341**	**265**	**181**
Karabu	1995	4	9.9	40.5	24	51
	1996	11	7.94	148.2	570	333
	1997	5	2	24.2	83	90
	1999	9	4.1	166	399	479
	2000	11	4.3	168	224	201
	2001	8	2.55	2846.3	3703	5219
	2002	2	1.4	36	40	45
	2003	1	1	28	25	30
	2004	1	3	12	13	77
	2005	2	0.81	207	21	26
	2006	3	2.61	44	48	7
	2007	2	0.42	14	14	19
	Total	**59**	**53.1**	**3543**	**5199**	**6606**

Table 5.67: Fruits and vegetable consumption in adults in selected countries

Country	Year	Mean Fruit intake (g/d)	Mean Vegetable intake (g/d)
Developed			
Hong Kong (SAR, PR China)	2010	146.81	176.96
Denmark*	2013	151.70	162.08
Germany*	2013	171.36	118.02
UK*	2013	130.02	97.86
France*	2013	136.56	145.15
US**	2015	189.30	255.00
Netherlands*	2013	102.36	127.79
Italy*	2013	90.83	150.81
Austria*	2013	163.58	89.52
Developing			
Malaysia	2012	179.00	133.00
India**	2015	158.20	105.70
PR China**	2015	222.10	262.80
Ghana**	2015	149.80	36.10
Ethiopia**	2015	114.70	51.20
Uganda**	2015	464.10	24.40
Samoa**	2015	441.00	9.10

* Data from EFSA database, updated 2013 (53)

** Data from GEMS/Food database, updated 2015 (54)

Source: Pem.D, Jeewon.R , 2015

Table 5.68 : Consumption exposure to metals from soil through vegetables

Type	concentration, mg/Kg					Reference/Season
	Cu(ppm)	Pb(ppm)	Zn(ppm)	Mn(ppm)	Ni(ppm)	
Cabbage	0.58	5.87	0.3	0.89	23.59	Measured in Wet
Lettuce	2.08	7.47	0.37	1.99	30.39	Measured in Wet
Red beet	0.72	7.67	0.38	2.79	21.39	Measured in Wet
Cabbage(garden)	0.62	2.01	0.21	0.53	1.2	Measured in Wet
Cabbage	0.6	6.07	0.29	0.88	22.47	Measured in dry
Lettuce	2.2	7.37	0.36	1.97	29.47	Measured in dry
Red beet	0.73	7.57	0.37	2.76	20.67	Measured in dry
Cabbage(garden)	0.51	2	0.2	0.52	1.18	Measured in dry
C factor	0.085	0.085	0.085	0.085	0.085	Latif et al. 2018
RfD	0.04	0.004	0.30	0.033	0.02	US-EPA IRIS 2006
D food intake adult(kg/p/day)					0.345	Latif et al. 2018
D food intake children(kg/p/day)					0.232	Latif et al. 2018
B average weight of Ethiopia for Adult in kg					53.07	CSA and WFP 2019
B average weight Children in kg					32.7	Latif et al. 2018

Source: Own Laboratory results, 2019

Table 5.69: The heavy metal of DIM and HDI of vegetable in wet and dry season by adult and children in Sabata town

Metal	Season	Human	Cabbage	Lettuce	Red beet root	Garden Cabbage	HRI	HRI	HRI	HRI
			DIM	DIM	DIM	DIM	Cabbage	Lettuce	Red beet	Garden Cabbage
Cu	WE	Adult	0.0003	0.0008	0.0004	0.0003	0.0075	0.02	0.049	0.0075
	WE	Child	0.0003	0.0013	0.0004	0.0003	0.0075	0.033	0.01	0.0075
	DR	Adult	0.0003	0.0012	0.0004	0.00027	0.0075	0.03	0.01	0.007
	DR	Child	0.003	0.0013	0.0004	0.0003	0.075	0.033	0.01	0.05
Pb	WE	Adult	0.003	0.0041	0.0042	0.0011	0.75	1.03	1.05	0.28
	WE	Child	0.004	0.005	0.005	0.0012	1	1.25	1.25	0.3
	DR	Adult	0.0034	0.0041	0.0042	0.0011	0.85	1.03	1.05	0.0049
	DR	Child	0.0037	0.0044	0.0064	0.0012	0.93	1.1	1.6	0.3
Zn	WE	Adult	0.0002	0.0002	0.0002	0.0001	0.001	0.001	0.001	0.0003
	WE	Child	0.0001	0.0002	0.0003	0.0001	0.0003	0.001	0.001	0.0003
	DR	Adult	0.00016	0.0002	0.0002	0.0001	0.0005	0.0007	0.0007	0.0003
	DR	Child	0.00017	0.0001	0.0002	0.0001	0.0006	0.0003	0.0007	0.0004

MN	WE	Adult	0.00049	0.0012	0.0015	0.0003	0.015	0.036	0.045	0.01
	WE	Child	0.00054	0.0017	0.002	0.0003	0.016	0.052	0.06	0.01
	DR	Adult	0.00048	0.0011	0.002	0.0002	0.016	0.033	0.06	0.006
	DR	Child	0.00053	0.0012	0.002	0.0002	0.02	0.036	0.06	0.006
Ni	WE	Adult	0.013	0.0156	0.012	0.001	0.65	0.78	0.6	0.05
	WE	Child	0.014	0.0183	0.013	0.001	0.7	0.92	0.65	0.05
	DR	Adult	0.0124	0.0163	0.011	0.001	0.62	0.81	0.55	0.05
	DR	Child	0.0201	0.018	0.012	0.001	1.01	0.9	0.6	0.05
Daily vegetable intake adult(kg/p/day)									0.345	Latif et al. 2018
Daily vegetable intake children(kg/p/day)									0.232	Latif et al. 2018
Body average weight of Ethiopia for Adult in kg									53.07	CSA and WFP 2019
Body average weight Children in kg									32.7	Latif et al. 2018

Source: Own data and complied from different Sources, 2019

Cu- copper, Pb- lead, Mg-Manganese, Zn-Zinc, Ni-Nickel, CB-Cabbage, LU-Lettuce, GC-Garden Cabbage, RB- Red beet root, We-Wet, DR-Dry,

Table 5.70: Physico-Chemical Parameters in Sabata and Harbu Dano river (January, 2019)

	2019					
Rivers	**Upper**	**Middle**	**Lower**	**Upper**	**Middle**	**Lower**
Altitude(M)	2252	2201	2185	2279	2242	2174
Northing	0459064	0459479	0459415	0461002	0460853	0459420
Easting	0986124	0985145	0984611	0986760	0985676	0984588
Physico-Chemical Parameters						
Temperature (^oC)	23.4	20.9	20.3	20.9	18.3	20.3
Turbidity (FAU)	37	33	176	39	207	55
EC (µS·cm−1)	167.6	286	1003	192.4	499	2126
pH	7.7	7.7	4.9	7.7	7.3	7.9
DO (mg/l)	3.81	0.8	0.65	5.85	0.13	2.27
DO (%)	58.6	51.6	9.3	88.4	1.3	32.7

TDS (mg/l)						
Alkalinity(T)mg/l	62	160	0	30	240	300
NO_3^- mg/l	2.2	3.08	16.28	8.36	5.28	2.64
TN (mg/l)	0	2.3	4.3	0	6.4	5.8
TP (mg/l)	0.37	1.44	5.20	0.49	6.65	6.19
Cr(VI) mg/l	0.019	0.012	0.034	0.004	0.005	0.003
Pb µg/l	0.001	79.8	38.2	0.005	75.3	36.2

NB. HB-----Harbu Dano river, S-------Sabata river

Coordinate of the sample sites (water Sampling sites by Using GPS) 13/02/2019

Laboratory of Ethiopia Aquatic and Fisheries Research Institute, Sabata town, Febuary, 2019

Table 5.71:Coordinate of the sample sites (water Sampling sites by Using GPS) 13/02/2019

Sampled sites	Altitude(m)	Latitude	Longitude
S1	2279	37p0461002	UTM 0986760
S2	2242	37 p0460853	UTM 0985676
S3	2174	37p0459420	UTM 0984588
HD1	2252	37p0459064	UTM 0986124
HD2	2201	37 p 0459479	UTM 0985145
	2185	37p0459415	UTM 0984611

Source: own Sample taken from upstream, middle, and lower stream, 2019

Upper Stream-Mogle mountain area (38^0 38’0”E, $38^0$40’0”E), $8^0$54’40”N and 8^0 56’0’’N 1,2, 3

Middle Stream-Harbu Dano stream (1, 2 and 3) Down (Lower) stream (around Muslim abattoir)-1,2,3

Table 5.77: GPS coordinate of waste water sample sites of manufacturing industries

S/N	Type of manufacturing industries	Elevation (M.)	Latitude (Northing)	Longitude (Easting)
1	Asker Ethiopia Blocket Plc	2268	08^{0} 55’170’’	038^{0} 38’748’’
2	Ayka Addis Textile and Investment Group	2299	08^{0} 55’125’’	038^{0}39’701’’
3	Balezaf Alcohol and Liquor Plc	2249	08^{0}55’117’’	038^{0}38’283’’
4	Best Plastics Industry Plc	2305	08^{0}55’258’’	038^{0}39’696’’
5	Hafde Tannery plcPlc	2285	08^{0}55’375’’	038^{0}38’955’’
6	National Alcohol and Liquor Plc	2227	08^{0}54’848’’	038^{0}38’00’’
7	Pacific Industrial Plc	2240	08^{0} 54’970’’	038^{0} 38’241’’
8	Sabata Agro-Industry Plc	2262	08^{0} 55’160’’	038^{0} 38’681’’
9	Walia Steel Industry Plc	2206	08^{0} 55’282’’	038^{0} 39’704’’
10	Zalash Cosmetics and Plastic Plc	2311	08^{0} 55’414’’	038^{0} 39’ 708’’
11	Arbaminch Textile plc	2186	08^{0} 54’074’’	038^{0} 37’ 153’’
12	Atebela Roge Chafe area	2118	08^{0} 52’657’’	038^{0} 36’ 930’’
13	BMET Cable Plc	2124	08^{0} 53’207’’	038^{0} 34’ 031’’
14	Sabata Abattoir	2122	08^{0} 52’375’’	038^{0} 37’ 014’’
15	Home Tech	2119	08^{0} 52’718’’	038^{0} 33’ 142’’
16	Ker Water Bottling	2119	08^{0} 52’804’’	038^{0} 33’ 296’’
17	Meta Abo Brewery S.C	2199	08^{0} 54’658’’	038^{0} 35’ 772’’
18	Nova bottling	2186	08^{0} 54’028’’	038^{0} 37’ 162’’
19	One Natural Purified water	2217	08^{0} 54’375’’	038^{0} 36’ 664’’
20	Sagin Dima Textile Plc	2136	08^{0} 53’577’’	038^{0} 34’ 705’’
21	Atebella Open ditch along road	2139	08^{0} 53’113’’	038^{0} 37’ 015’’

Source: own laboratory points GPS reading, 2019

AA EPA, Lab.results, Date of sample arrival: 20/03/2019, Date of analysis: 20/03/-08/04/2019

Table 5.78: The results of physio-chemicalparameters of the waste water samples from different factories sampling sites in Sabata town (March.20/2019)

Parameters	Raw waste water effluent concentration							
	W8	**WAY2**	**WCO4 (UP)**	**W6 (MA)**	**WAM 7**	**WMI 1**	**WHD 3**	**WNA 5**
TSS, mg/l	248	44	34	148	216	47	725	228
Conductivity, µs	3330	5710	604	5450	4340	5490	10740	2390
COD, mg/l	1025	58	27	271	906	55	5450	2900
Phosphorous ,mg/l	ND	<0.0001	<0.0001	11.6	ND	<0.0001	ND	1.4
Hydrogen Ion Concentration,PH	6.97	7.89	7.45	8.60	8.81	7.72	4.95	4.7
Nitrogen, mg/l	38	33	10	250	62	36	460	25
Ammonia, mg/l	2	4.5	3.5	30.5	6	6	51	2
BOD, mg/l	ND	38	22	148	268	46	464	ND
Water Temperature(^{0}c)	30.5	30.9	22.5	23.8	30.9	30.7	21.9	26

Source: own sample taken (March, 2019)

N.B: WM1-Mars cattle fattening, Paints and Plastic factory, WAY 2- Ayka Addis Textile and Investment Group, WHD 3-Hafde Tannery, WCO 4- Upstream (Sabata Erecha Area) Control group, WNA 5-National Alcohol and Liquors Factory Plc, WN 6-Meta Abo Brewery S.C, WAM 7-Arba Minch Textile Plc, W8-Atebela Chafe downstream (Nearby Sabata Abbatior area)

Table 5.79: Environmental Laboratory resultsof some Selected industries (2016-2019)

Parameters	Sabata EPAFCC/Balezaf Alchool Factory(July08/2017)		Sabata agro-industry(July 08/2017)	HAFDE(July 08/2017)	Ayka Addis Textile Plc(29/05/2018)	Arbamich Textile S.c (August 01/2016)	Ayika Addis textile plc(30/1/2018)	Mahavier textile plc	Jiadong textile plc	Meta abo s.c
	Emit Effluen	Emit Wash								
Fat,Oil and Grease(FOG) in mg/l	557.05	2353.73	319.21	290.36	11240		172.01		136.55	
BOD in mg/l	4880	14928	300	1024	42.24	37.20	173.64	44.16	89.62	90
COD in	14624.	53205.	711.20	2517.3	157.92	115.75	352.80	144	714	240

mg/l	91	94		3						
TSS in mg/l	860	3480	770	135	10	15	290	25	23.33	ND
NH4-N in mg/l	17.84	9.80	10.48	49.79	0.53	RND	39.06	12.89	2.83	
Ph	4	4.18	6.46	-		8.59	7.31	6.95	7.03	8.11
TP in mg/l	11.10	17..04	3.63	4.10		2.18	1.91		1.04	5.47
TN in mg/l	151..41	893.76	18.72		13.64	4.33	58.59	24	ND	1.71
Cr				7.01						
S^{-2}				150.59						
TDS						680			876.67	
AS µg/L										3.49
Hg µg/L										0.24
Pb mg/l										ND

Source: Sabata EFCCA, 2019

Table 5.81: phytoremediation for polluted water, soil and vegetable

Contaminant	Media	Process	Plant	Reference
Lead	Soil	Phytoextraction	*Indian Mustard*	Blaylock et al. 1999; US EPA 2001
			Brassica juncea cultivator	Kumar et al.1995; US EPA 2001
		Phytostabilization	*Brassica juncea seedlings*	Salt et al. 1995; US EPA 2001
	Water	Rizofilitration	*Indian Mustard*	Dushenkov et al. 1995; US EPA 2001
			Indian Mustard	Salt et al. 1997; US EPA 2001
			Watermalfoil	Wang et al 1997; US EPA 2001
Copper	Soil	Phytoextraction	*NA*	McGrath 1998; US EPA 2001
		Phytostabilization	*Agrostis tenuis and Festuca rubra*	Smith and Bradshaw 1979; US EPA 2001
	Water	Rizofilitration	*Indian Mustard*	Dushenkov et al.1995; US EPA 2001
			Watermilfoil	Wang et al. 1996; US EPA 2001
			Duckweed, water hyacinth	Zayed et al.1998,Zhu et al.1999; US EPA 2001
Manganse	water	Rizofilitration	*12 wetland plants*	Qian et al. 1999; US EPA 2001
Nickel	Soil	Phytoextraction	*Berkheya coddii*	Robinson et al.1997; US EPA 2001
		Phytoextraction	*Native plants(herbs, shrubs , and trees)*	Brooks et al. 1998; US EPA 2001
	water	Rhizofilitration	*Brassica junea*	Dushenkov et al. 1995; US EPA 2001

Source: US EPA 2001

Table 5.82 : Estimated cost for utilization of Phytoremediation

Process	Remediation	Estimated cost($)	Reference
phytoextraction	one acre of 20 inch sandy loam soil	$60,000 to $100,000	Salt et al.1995; US EPA 2001
	excavation and storage of soil	$400,000	Salt et al.1995; US EPA 2001
Removal of Contaminate	removal from ground water using aquatic plants	$1.78 per thousand gallons	ESTCP, 1999; US EPA 2001
Rhizofiltration	sunflowers	$2.00 to $6.00 per thousand gallons	Cooney, 1996; US EPA 2001
Phytostabilization	cropping system	$200 to $10,000 per hectare	Cunningham et al. 1995; US EPA 2001
Hydraulic control and remediation	20-foot deep aquifer at a oneacre	$660,000 for conventional pump-and-treat	Gatliff, 1994; US EPA 2001
Phytoremediation	using trees	$250,000	Gatliff, 1994; US EPA 2001

Source: US EPA 2001

Table 5.83The results of post-Hoc analysis using Tukey's method on the effects of factories on temperature

factory	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Ayka Addis Textile and Investment Group	30	30.9	30.45	0.1945691	29.98992	30.91008	a
Arba Minch Textile Plc	30	30.9	30.45	0.1945691	29.98992	30.91008	a
Paints and Plastic factory	30.1	30.7	30.40	0.1945691	29.93992	30.86008	a
Atebela Chafe downstream	28	29.02	28.50	0.1945691	28.03992	28.96008	b
National Alcohol and Liquors Factory Plc	25	26.01	25.50	0.1945691	25.03992	25.96008	c
Meta Abo Brewery S.C	22	23.8	22.90	0.1945691	22.43992	23.36008	d
Upstream (Sabata Erecha Area)	22	22.5	22.25	0.1945691	21.78992	22.71008	de
Hafde Tannery	21	21.9	21.45	0.1945691	20.98992	21.91008	e

Table 5.84. The results of post-Hoc analysis using Tukey's method on the effects of factories on pH

factory	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Meta Abo Brewery S.C	8.4	8.6	8.5	0.5143473	7.283762	9.716238	a
Arba Minch Textile Plc	8	8.81	8.41	0.5143473	7.188762	9.621238	a
Ayka Addis Textile and Investment Group	7.8	7.89	7.85	0.5143473	6.628762	9.061238	a
Paints and Plastic factory	7.7	7.72	7.71	0.5143473	6.493762	8.926238	a
Upstream (Sabata Erecha Area)	7.4	7.45	7.43	0.5143473	6.208762	8.641238	ab
Atebela Chafe downstream	6.5	6.97	6.74	0.5143473	5.518762	7.951238	ab
Hafde Tannery	7.5	4.95	6.23	0.5143473	5.008762	7.441238	ab
National Alcohol and Liquors Factory Plc	4.7	4.5	4.60	0.5143473	3.383762	5.816238	b

Table 5.85 the results of post-Hoc analysis using Tukey's method on the effects of factories on electrical conductivity µmhos/cm, 25 ^{0}c

Factories	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Hafde Tannery plc	10450	10470.05	10460	8.518887	10439.856	10480.144	a
Ayka Addis Textile and Investment Group	5700.05	5710.01	5705	8.518887	5684.856	5725.144	b
Paints and Plastic factory	5489	5490.01	5489.5	8.518887	5469.356	5509.644	c
Meta Abo Brewery S.C	5423.07	5450.04	5436.5	8.518887	5416.356	5456.644	d
Atebela Chafe downstream	5410	5360.03	5385	8.518887	5364.856	5405.144	e
Arba Minch Textile Plc	4330.02	4340.01	4335	8.518887	4314.856	4355.144	f
National Alcohol and Liquors Factory Plc	2389.01	2390	2389.5	8.518887	2369.356	2409.644	g
Upstream (Sabata Erecha Area)	603	604.01	603.5	8.518887	583.356	623.644	h

Table 5.86 The results of post-Hoc analysis using Tukey's method on the effects of factories on Biological Oxygen Demand (BOD,mg/l)

factory	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Hafde Tannery	464	460	462	22.19677	409.512988	514.48701	a
Arba Minch Textile Plc	268	265	266.5	22.19677	214.012988	318.98701	b
National Alcohol and Liquors Factory Plc	265	257	261	22.19677	208.512988	313.48701	b
Atebela Chafe downstream	256	253	254.5	22.19677	202.012988	306.98701	b
Meta Abo Brewery S.C	270	148	209	22.19677	156.512988	261.48701	b
Paints and Plastic factory	46	45	45.5	22.19677	-6.987012	97.98701	c
Ayka Addis Textile and Investment Group	38	35	36.5	22.19677	-15.987012	88.98701	c
Upstream (Sabata Erecha Area)	22	20	21	22.19677	-31.487012	73.48701	c

Table 5.87 The results of post-Hoc analysis using Tukey's method on the effects of factories on Chemical Oxygen Demand (COD,mg/l)

factory	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Hafde Tannery	5450	4970	5210	136.9144	4886.2489	5533.7511	a
National Alcohol and Liquors Factory Plc	2900	2380	2640	136.9144	2316.2489	2963.7511	b
Arba Minch Textile Plc	906	698	802	136.9144	478.2489	1125.7511	c
Atebela Chafe downstream Nearby Sabata Abattoir area	1025	310	667.5	136.9144	343.7489	991.2511	c
Meta Abo Brewery S.C	271	150	210.5	136.9144	-113.2511	534.2511	c
Paints and Plastic factory	55	37	46	136.9144	-277.7511	369.7511	c
Ayka Addis Textile and Investment Group	58	33	45.5	136.9144	-278.2511	369.2511	c
Upstream (Sabata Erecha Area)	27	24	25.5	136.9144	-298.2511	349.2511	c

Table 5.88 the results of post-Hoc using Tukey's method on the effects of factories on TSS, mg/l

factory	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Hafde Tannery	725	720	722.5	1.125992	719.83745	725.16255	a
Atebela Chafe downstream Nearby Sabata Abattoir area	248	245	246.5	1.125992	243.83745	249.16255	b
National Alcohol and Liquors Factory Plc	228	224	224	1.125992	221.33745	226.66255	c
Arba Minch Textile Plc	216	214	215	1.125992	212.33745	217.66255	d
Meta Abo Brewery S.C	148	145	146.5	1.125992	143.83745	149.16255	e
Paints and Plastic factory	47	46	46.5	1.125992	43.83745	49.16255	f
Ayka Addis Textile and Investment Group	44	42	43	1.125992	40.33745	45.66255	f
Upstream (Sabata Erecha Area)	34	32	33	1.125992	30.33745	35.66255	g

Table 5.89 The results of post-Hoc analysis using Tukey's method on the effects of factories on Nitrogen, mg/l

factory	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Hafde Tannery	460	670	565	63.53651	414.760022	715.24	a
Meta Abo Brewery s.c	68	250	159	63.53651	8.760022	309.24	b
Atebela Chafe down stream	38	240	139	63.53651	-11.239978	289.24	b
National Alcohol and Liquors Factory Plc	25	60	54	63.53651	-96.239978	204.24	b
Arba Minch Textile Plc	46	62	42.5	63.53651	-107.739978	192.74	b
Ayka Addis Textile and Investment Group	0	33	30.5	63.53651	-119.739978	180.74	b
Paints and Plastic factory	0	36	29.5	63.53651	-120.739978	179.74	b
Upstream (Sabata Erecha Area)	0	10	10	63.53651	-140.239978	160.24	b

Table 5.90 The results of post-Hoc analysis using Tukey's method on the effects of factories on Phosphours (P) ,mg/l

factory	Wet	Dry	mean	SE	lower.CL	upper.CL	group
Hafde Tannery	28.5	30.2	2.935000e+01	0.293987	28.654830	30.0451697	a
Meta Abo Brewery s.c	11.2	11.6	1.155000e+01	0.293987	10.854830	12.2451697	b
Arba Minch Textile Plc	2.8	3.1	2.950000e+00	0.293987	2.2548303	3.6451697	c
National Alcohol and Liquors Factory Plc	1.4	2.2	1.800000e+00	0.293987	1.1048303	2.4951697	cd
Atebela Chafe downstream Nearby Sabata Abattoir area	1.4	1.4	1.400000e+00	0.293987	0.7048303	2.0951697	cde
Ayka Addis Textile and Investment Group	0.0001	0.5	2.500000e-01	0.293987	-0.445169	0.9451697	de
Paints and Plastic factory	0.0001	0.4	2.000000e-01	0.293987	-0.495169	0.8951697	de
Upstream (Sabata Erecha Area)	0.0001	0.001	4.385381e-15	0.293987	-0.695169	0.6951697	e

Table 5.91. The sample results of temperature of manufacturing industries wastes

Year	Name of Manufacturing industries	Temperature in ($^{O}{}_{c}$)
2016	Arbamich Textile S.C	37.2
2016	Mahavier Textile Plc	32
2016	Jiadong Textile plc	29
2017	Meta Abo Brewery S.C	23
2017	Sabata EPAFCC/Balezaf Alcohol Factory	28
2017	Sabata Agro-Industry Plc	25
2017	Hafde Tannery plc	31
2017	Ayka Addis Textile and Investment Group	34
2018	Ayka Addis Textile and Investment Group	21
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	30.7
2019	WAY 2(Ayka Addis Textile and Investment Group)	30.9
2019	WHO 3(Hafde Tannery)	21.9
2019	WCO 4(Upstream (Sabata Erecha Area)	22.5
2019	WNA 5(National Alcohol and Liquors Factory Plc)	26
2019	WN 6(Meta Abo Brewery S.C)	23.8
2019	WAM 7(Arba Minch Textile Plc)	30.9
2019	W8(Atebela Chafe downstream)	29

Table 5.92 The sample results of pH log units of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	pH
2016	Arbamich Textile S.C	8.59
2016	Mahavier Textile Plc	6.95
2016	Jiadong Textile plc	7.03
2017	Meta Abo Brewery S.C	8.3
2017	Sabata EPAFCC/Balezaf Alcohol and Liquors Factory	4
2017	Sabata Agro-Industry Plc	6.46
2017	Hafde Tannery plc	4.7
2017	Ayka Addis Textile and Investment Group	6.5
2018	Ayka Addis Textile and Investment Group	7.31
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	7.72
2019	WAY 2(Ayka Addis Textile and Investment Group)	7.89

2019	WHO 3(Hafde Tannery)	4.95
2019	WCO 4(Upstream (Sabata Erecha Area)	7.45
2019	WNA 5(National Alcohol and Liquors Factory Plc)	4.7
2019	WN 6(Meta Abo Brewery S.C)	8.6
2019	WAM 7(Arba Minch Textile Plc)	8.81
2019	W8(Atebela Chafe downstream)	6.97

Table 5.93 The sample results of conductivity, µs/cm of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	Conductivity(EC) , µs/cm
2016	Arbamich Textile S.C	887
2016	Mahavier Textile Plc	920
2016	Jiadong Textile plc	1210
2017	Meta Abo Brewery S.C	1320
2017	Sabata EPAFCC/Balezaf Alcohol Factory	876
2017	Sabata Agro-Industry Plc	1560
2017	Hafde Tannery plc	1780
2017	Ayka Addis Textile and Investment Group	1320
2018	Ayka Addis Textile and Investment Group	1200
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	5490
2019	WAY 2(Ayka Addis Textile and Investment Group)	5710
2019	WHO 3(Hafde Tannery)	10470
2019	WCO 4(Upstream (Sabata Erecha Area)	600
2019	WNA 5(National Alcohol and Liquors Factory Plc)	2390
2019	WN 6(Meta Abo Brewery S.C)	5450
2019	WAM 7(Arba Minch Textile Plc)	4340
2019	W8(Atebela Chafe downstream)	5410

Table 5.94 The sample results of BOD mg/l of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	BOD, mg/l
2016	Arbamich Textile S.C	37.2
2016	Mahavier Textile Plc	144
2016	Jiadong Textile plc	89.62
2017	Meta Abo Brewery S.C	240
2017	Sabata EPAFCC/Balezaf Alcohol Factory	4880
2017	Sabata Agro-Industry Plc	300
2017	Hafde Tannery plc	1024
2017	Ayka Addis Textile and Investment Group	42.24
2018	Ayka Addis Textile and Investment Group	173.64
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	46
2019	WAY 2(Ayka Addis Textile and Investment Group)	38
2019	WHO 3(Hafde Tannery)	464
2019	WCO 4(Upstream Sabata Erecha Area)	22
2019	WN 6(Meta Abo Brewery S.C)	148
2019	WAM 7(Arba Minch Textile Plc)	268
2019	W8(Atebela Chafe downstream)	256

Table 5.95 The sample results of COD mg/l of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	COD, mg/l
2016	Arbamich Textile S.C	115.75
2016	Mahavier Textile Plc	44.16
2016	Jiadong Textile plc	714
2017	Meta Abo Brewery S.C	90
2017	Sabata EPAFCC/Balezaf Alcohol Factory	14928
2017	Sabata Agro-Industry Plc	711.2
2017	Hafde Tannery plc	2517.33
2017	Ayka Addis Textile and Investment Group	157.92
2018	Ayka Addis Textile and Investment Group	352.8
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	55
2019	WAY 2(Ayka Addis Textile and Investment Group)	58
2019	WHO 3(Hafde Tannery	5450

2019	WCO 4(Upstream Sabata Erecha Area)	27
2019	WNA 5(National Alcohol and Liquors Factory Plc)	2900
2019	WN 6(Meta Abo Brewery S.C)	271
2019	WAM 7(Arba Minch Textile Plc)	906
2019	W8(Atebela Chafe downstream)	1025

Table 5.96 The sample results of COD mg/l of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	COD, mg/l
2016	Arbamich Textile S.C	115.75
2016	Mahavier Textile Plc	44.16
2016	Jiadong Textile plc	714
2017	Meta Abo Brewery S.C	90
2017	Sabata EPAFCC/Balezaf Alcohol Factory	14928
2017	Sabata Agro-Industry Plc	711.2
2017	Hafde Tannery plc	2517.33
2017	Ayka Addis Textile and Investment Group	157.92
2018	Ayka Addis Textile and Investment Group	352.8
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	55
2019	WAY 2(Ayka Addis Textile and Investment Group)	58
2019	WHO 3(Hafde Tannery)	5450
2019	WCO 4(Upstream Sabata Erecha Area)	27
2019	WNA 5(National Alcohol and Liquors Factory Plc)	2900
2019	WN 6(Meta Abo Brewery S.C)	271
2019	WAM 7(Arba Minch Textile Plc)	906
2019	W8(Atebela Chafe downstream)	1025

Table 5.97 the sample results of TSS of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	TSS, mg/l
2016	Arbamich Textile S.C	15
2016	Mahavier Textile Plc	25
2016	Jiadong Textile plc	23.33
2017	Meta Abo Brewery S.C	ND
2017	Sabata EPAFCC/Balezaf Alcohol Factory	860
2017	Sabata Agro-Industry Plc	770
2017	Hafde Tannery plc	135

2017	Ayka Addis Textile and Investment Group	10
2018	Ayka Addis Textile and Investment Group	290
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	47
2019	WAY 2(Ayka Addis Textile and Investment Group)	44
2019	WHO 3(Hafde Tannery)	725
2019	WCO 4(Upstream (Sabata Erecha Area)	34
2019	WNA 5(National Alcohol and Liquors Factory Plc)	228
2019	WN 6(Meta Abo Brewery S.C)	148
2019	WAM 7(Arba Minch Textile Plc)	216
2019	W8(Atebela Chafe downstream)	248

Table 5.98 The sample results of Nitrate of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	Nitrate (NO3) in mg/l
2016	Arbamich Textile S.C	4.33
2016	Mahavier Textile Plc	24
2016	Jiadong Textile plc	ND
2017	Meta Abo Brewery S.C	17.32
2017	Sabata EPAFCC/Balezaf Alcohol Factory	151.41
2017	Sabata Agro-Industry Plc	18.72
2017	Hafde Tannery plc	565.08
2017	Ayka Addis Textile and Investment Group	13.64
2018	Ayka Addis Textile and Investment Group	58.59
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	36
2019	WAY 2(Ayka Addis Textile and Investment Group)	33
2019	WHO 3(Hafde Tannery)	460
2019	WCO 4(Upstream Sabata Erecha Area)	10
2019	WNA 5(National Alcohol and Liquors Factory Plc)	25
2019	WN 6(Meta Abo Brewery S.C)	250
2019	WAM 7(Arba Minch Textile Plc)	62
2019	W8(Atebela Chafe downstream)	38

Table 5.99 The sample results of Ammonia of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	Ammonia (NH4) mg/l
2016	Arbamich Textile S.C	ND
2016	Mahavier Textile Plc	12.89
2016	Jiadong Textile plc	2.83
2017	Meta Abo Brewery S.C	1.71
2017	Sabata EPAFCC/Balezaf Alcohol Factory	17.8
2017	Sabata Agro-Industry Plc	10.48
2017	Hafde Tannery plc	49.79
2017	Ayka Addis Textile and Investment Group	0.53
2018	Ayka Addis Textile and Investment Group	39.06
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	6
2019	WAY 2(Ayka Addis Textile and Investment Group)	4.5
2019	WHO 3(Hafde Tannery)	51
2019	WCO 4(Upstream (Sabata Erecha Area)	2
2019	WNA 5(National Alcohol and Liquors Factory Plc)	3.5
2019	WN 6(Meta Abo Brewery S.C)	30.5
2019	WAM 7(Arba Minch Textile Plc)	6
2019	W8(Atebela Chafe downstream)	20

Table 5.100 sample results of Phosphorus of manufacturing industries water contaminate water

Year	Name of Manufacturing industries	Phosphorus in mg/l
2016	Arbamich Textile S.C	2.18
2016	Mahavier Textile Plc	12
2016	Jiadong Textile plc	1.04
2017	Meta Abo Brewery S.C	5.47
2017	Sabata EPAFCC/Balezaf Alcohol Factory	11.1
2017	Sabata Agro-Industry Plc	3.63
2017	Hafde Tannery plc	4.1

2017	Ayka Addis Textile and Investment Group	2.4
2018	Ayka Addis Textile and Investment Group	1.91
2019	WM1(Mars cattle fattening, Paints and Plastic factory)	0.0001
2019	WAY 2(Ayka Addis Textile and Investment Group)	0.0001
2019	WHO 3(Hafde Tannery)	3.1
2019	WCO 4(Upstream (Sabata Erecha Area)	0.0001
2019	WNA 5(National Alcohol and Liquors Factory Plc)	1.4
2019	WN 6(Meta Abo Brewery S.C)	11.6
2019	WAM 7(Arba Minch Textile Plc)	2.3
2019	W8(Atebela Chafe downstream)	1.4

Table Permissible limit for water quality

Parameter	FEPA	WHO 1996	WHO, 2010	WHO, 2003	USEPA MPL	FAO, 1985	WHO, FAO & Ewers ,MPL	Awashthi, 2000	NEMA, 1999	EDWQ
Temp.	<40	12-25								
pH	6-9	5.5-8.5	6.5-8.5						6-8	
Ec		40	500						400	
BOD	50	40								
COD		80							100	
TSS	30	NS		50						
NH3			1.5							
TN	10								10	
TP	10		5						10	
Turbidity		5	5						300	
Cu	<1		0.10		1.3	0.20	0.017	0.05	0.1	2.0
Pb	<1		0.01	0.01	0.015	5	0.065	0.10	0.1	0.01
Mn			0.5		0.05	0.20	0.20	0.10		0.5
Ni	<1			0.1	0.1	0.20	1.40	-		
Zn	<1		0.2			0.20		5		5

Table 5.102 Surface water Quality Standard

Condition of surface water(WHO 2004)	pH	BOD5(mg/L	COD(mg/l)	SS(Mg/L)	Ammonia(Mg/l)
excellent	6.5-8	1.5	10	20	0.1
acceptable	6-8.4	3	20	40	0.3
slightly polluted	5.0-9.0	6	40	100	0.9
polluted	3.9-10.1	12	80	278	2.7
grossly polluted	<3.9->10.1	>12		>278	>2.7

Recommended water quality criteria

Parameter	Desirable Limit	Maximum Permissible Limit	Organization
Temperature	-	15	CCME
Ph	7-8.5	6.5-9.2	WHO
Do,Mg/L	5-5-9.5	-	CCME
Conductivity,us/cm	750	2500	WHO
TDS, mg/L	-	1500	ICMR
Nitrate, mg/L	25	50, drinking water	EC
Chloride, mg/L	100-700	Irrigation water	CCME
Phosphate, mg/L	0.35	6.1	CE,WHO
NH3, mg/L	1.37-2.20 for protection of acquatic animals	-	EC

Source: AAU,2017

Metal Concentrations in leafy vegetables (Cabbage, Lettuce, onion, Swisschard)

Elements mg/kg	Recommended Maximum Limit
AS	0.43
CD	0.2
CR	2.3
PB	0.3

Source: Fissaha Itana,2002; AAU,2017

Surface water quality classification

Parameter	Condition of the water				
	Excellent	Acceptable	Slightly Polluted	Polluted	Grossly Polluted
Ph	6.5-8	6-8.4	5-9	3.9-10.1	<3.9-10.1
Do(%)	68-112	75-150	50-150	20-200	<20-200
BOD5(Mg/L)	1.5	3	6	12	>12
COD(Mg/L)	10	20	40	80	>80
SS(Mg/L)	20	40	100	278	>278
Ammonia(mg/l)	0.1	0.3	0.9	2.7	>2.7
Nitrate(mg/l)	4	12	36	108	>108
Chloride(mg/l)	50	150	300	620	>620

Source: WHO,2004; AAU, 2017

Acceptable standards of surface water quality and domestic waste water after treatment

Parameter	Acceptable Standards	
	Netherlands surface water quality	Europe domestic waste water after treatment
BOD $_{20}$5 , Mg/l	<3	<25
COD , mg/l	<20	<125

Table 5.72: UK General Quality Assessment (GQA) criteria for rivers

GQA Grade	Description	BOD(mg/L)	NH3(mg/L)
A	Very good	2.5	0.25
B	Good	4	0.6
C	Fairly good	6	1.3
D	Fair	8	2.5
E	poor	15	9
F	Bad	<15	<9

Source: AAU,2017

Table 5.73: Recommended water quality criteria Discharge limits

Parameter	EEPA/ USEPA	DL	MPL	Organization
Temperature		-	15	CCME
PH	6-9	7-8.5	6.5-9.2	WHO
Do, mg/L		5-5-9.5	-	CCME
Conductivity (μcm)	100	750	2500	WHO
TDS (mg/L)	500	-	1500	ICMR
Nitrogen(mg/L)		25	50, drinking water	EC
Chloride (mg/L)		100-700	Irrigation water	CCME
Phosphate(mg/L)		0.35	6.1	CE,WHO
NH_3 (mg/L) Nh_3N (mg/L)	30 50	1.37-2.20 for aquatic animals	-	EC
BOD (mg/L)	200,90% removal			
COD (mg/L)	500			

Source: AAU, 2017

CCME-Canadian Council of Minister for Environment, WHO- World Health Organization, ICMR-Indian Council for Medical Research, EC- European Community

Table 5.74: Metal Concentrations in leafy vegetables (Cabbage, Lettuce, onion, Swiss chard)

Elements mg/kg	Recommended Maximum Limit
AS	0.43
CD	0.2
CR	2.3
PB	0.3

Source: Fissaha Itana, 2002; AAU,2017

Table 5.75: Surface water quality classification

Parameter	Condition of the water				
	Excellent	Acceptable	Slightly Polluted	Polluted	Grossly Polluted
Ph	6.5-8	6-8.4	5-9	3.9-10.1	<3.9-10.1
Do (%)	68-112	75-150	50-150	20-200	<20-200
BOD5 (mg/L)	1.5	3	6	12	>12
COD (mg/L)	10	20	40	80	>80
SS (mg/L)	20	40	100	278	>278
Ammonia (mg/L)	0.1	0.3	0.9	2.7	>2.7
Nitrogen (mg/L)	4	12	36	108	>108
Chloride (mg/L)	50	150	300	620	>620

Source: WHO, 2004; AACA, 2017

Table 5.76 : Acceptable standards of surface water quality and domestic waste water after treatment

Parameter	Acceptable Standards	
	Netherlands surface water quality	Europe domestic waste water after treatment
BOD $_{20}$5, mg/L	<3	<25
COD, mg/L	<20	<125

Table 5.72: UK General Quality Assessment (GQA) criteria for rivers

GQA Grade	Description	BOD (mg/L)	NH_3(mg/L)
A	Very good	2.5	0.25
B	Good	4	0.6
C	Fairly good	6	1.3
D	Fair	8	2.5
E	poor	15	9
F	Bad	<15	<9

Source: AAU,2017

Table 5.73: Recommended water quality criteria Discharge limits

Parameter	EEPA/Us EPA	DL	MPL	Organization
Temperature		-	15	CCME
PH	6-9	7-8.5	6.5-9.2	WHO
Do,mg/l		5-5-9.5	-	CCME
Conductivity(µcm)	100	750	2500	WHO
TDS (Mg/l)	500	-	1500	ICMR
Nitrogen(Mg/l)		25	50, drinking water	EC
Chloride (mg/l)		100-700	Irrigation water	CCME
Phosphate(Mg/l)		0.35	6.1	CE,WHO
NH3-(Mg/l) Nh3+-N(mg/l)	30 50	1.37-2.20 for aquatic animals	-	EC
BOD (mg/l)	200,90% removal			
COD(mg/l)	500			

Source: AAU, 2017

CCME-Canadian Council of Minister for Environment, WHO- World Health Organization, ICMR-Indian Council for Medical Research, EC- European Community

Table 5.74: Metal Concentrations in leafy vegetables (Cabbage, Lettuce, onion, Swiss chard)

Elements mg/kg	Recommended Maximum Limit
AS	0.43
CD	0.2
CR	2.3
PB	0.3

Source: Fissaha Itana, 2002; AAU,2017

Table 5.75: Surface water quality classification

Parameter	Condition of the water				
	Excellent	Acceptable	Slightly Polluted	Polluted	Grossly Polluted
Ph	6.5-8	6-8.4	5-9	3.9-10.1	<3.9-10.1
Do (%)	68-112	75-150	50-150	20-200	<20-200
BOD5 (mg/l)	1.5	3	6	12	>12
COD (mg/l)	10	20	40	80	>80
SS (mg/l)	20	40	100	278	>278
Ammonia (mg/l)	0.1	0.3	0.9	2.7	>2.7
Nitrogen (mg/l)	4	12	36	108	>108
Chloride (mg/l)	50	150	300	620	>620

Source: WHO, 2004; AACA, 2017

Table 5.76 : Acceptable standards of surface water quality and domestic waste water after treatment

Parameter	Acceptable Standards	
	Netherlands surface water quality	Europe domestic waste water after treatment
BOD $_{20}$5 , Mg/l	<3	<25
COD , mg/l	<20	<125

Operational Definition of terms

Water Quality- a parameter that not deviate water quality parameter from specified standard as well as water that contains permissible limit of physical, chemical and biological composition of water

Physical quality -portable water which has recommended physical water parameters in specific standard (FAO, WHO, US EPA, and others

Chemical quality-portable water which has recommended chemical water parameters in specific standard (FAO, WHO, US EPA and others

Heavy metal quality of water-a portable water which has recommended heavy metal water parameters in specific standard(FAO, WHO, US EPA and others)

Table : Respondents type of employment for welfare activities engaged in

Type of job engaged in	Frequency	Percent
Own farming	138	30.7
Trading (buying and selling)	99	22.0
Salary work	83	18.5
Causal or daily laborer	67	14.9
Job less	25	11.2
Only selling	10	2.2
Pension	2	0.4
Total	449	100.0

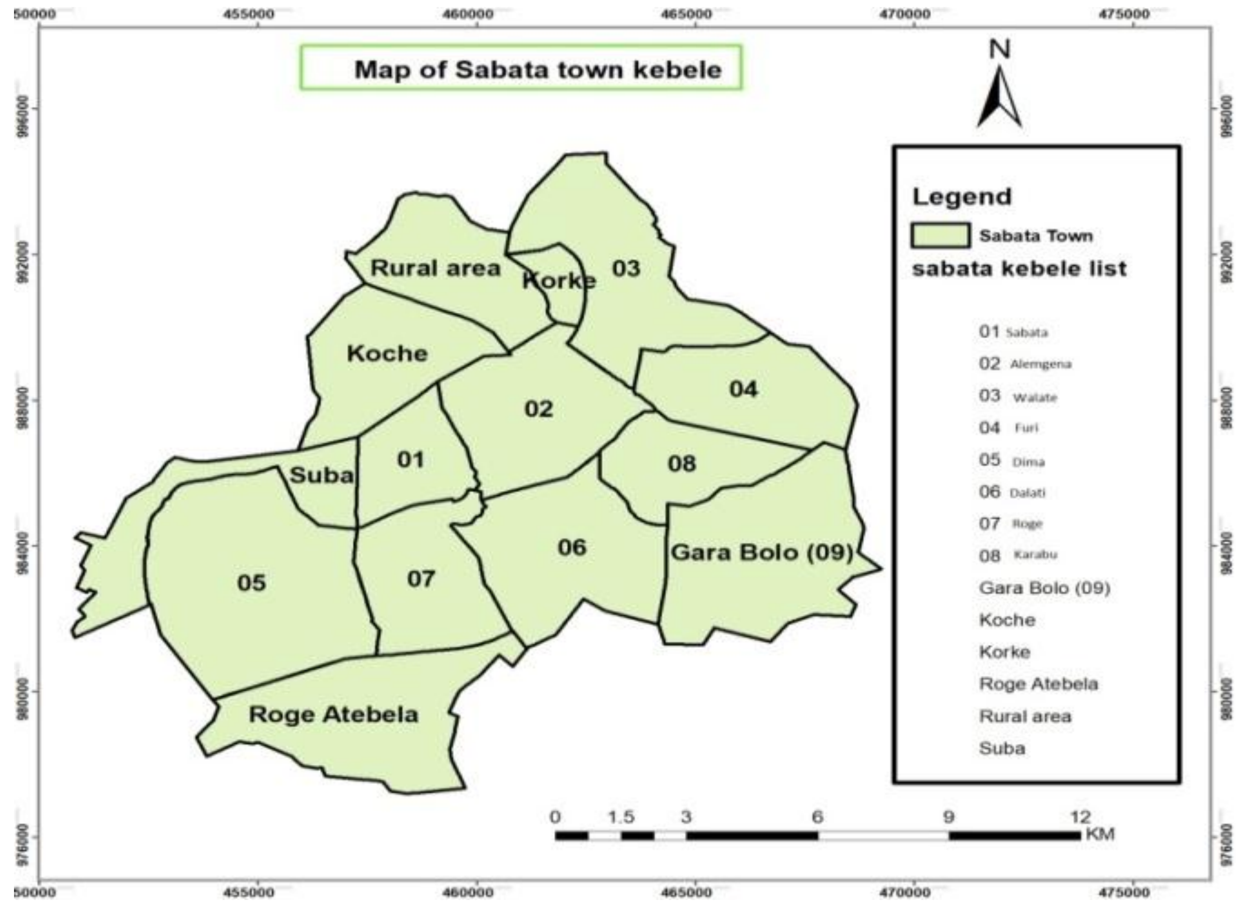


Figure 5.3 Map of Sabata town by Kebeles Administration

Table land size takings and number of industry in Sabata town

Name of kebeles	Year	Number of operational industries	Land size takings (ha)
Sabata	2006-2019	6	57.5
Alemgena	2006-2019	6	5.54
Walate	2006-2019	3	3.3
Furi	2000-2019	83	55.14
Dima	2003-2019	24	44
Roge	2007-2019	8	8.22
Karabu	2003-2019	59	53.1

Source: computed from data base of Oromia Investment Comission, 2019

Appendix 1

- East Oromia Branch(Adama)-Arsi Zone, East and West Hararghe Zone, East Shewa Zone (including Bishoftu, Mojo & other towns)
- Central Oromia Branch(Dukem)-West Shewa Zone, North Shewa Zone, South West Shewa Zone, & Oromia Special Zone Surrounding Finfine (OSZSF)
- South West Oromia Branch(Jimma)-Jimma Zone, Iluaba bor Zone, & Buno Bedele Zone
- West Oromia Branch(Nekemte)- West Wallega Zone, East Wallega Zone, Kellam Wallega and Horro Guduru Wallega Zone
- South Oromia Branch- Borena Zone, Gujii Zone, West Gujii and West Arsi zone.

Appendix 2 Proclamations and regulations

FDRE 1975, Government Ownership of Urban Land and Extra Houses. Proclamation No. 47/1975. Negarit Gazette ,Year 34, No. 41. Addis Ababa, Ethiopia.

FDRE 1995, Constitution of the Federal Democratic Republic of Ethiopia. Proclamation No. 1/1995. Negarit Gazette, Year 1, No.1.Addis Ababa, Ethiopia.

FDRE 1997, Ethiopia Environmental Policy. Environmental Protection Authority in collaboration with Ministry of Economic Development and Cooperation, Addis Ababa, Ethiopia.

FDRE 2000, Ethiopian Water Resources Management. Proclamation No. 197/2000, Negarit Gazette , 6th year, No.25, Addis Ababa, Ethiopia.

FDRE 2002, Environmental Pollution Control. Proclamation No. 300/2002, Negarit Gazette, 9th Year, No.2. Addis Ababa, Ethiopia.

FDRE 2002, Environmental Impact Assessment. Proclamation No. 299/2002, Negarit Gazette, 9th Year, No 11. Addis Ababa, Ethiopia.

FDRE 2002, Environmental Protection Organs Establishment Proclamation. Proclamation No. 295/2002, Negarit Gazette, 9th Year, No.7. Addis Ababa, Ethiopia.

FDRE 2002, Re-enactment of Urban Lands Lease Holding. Proclamation No.272/2002. Negarit Gazette, Year 8, No. 19. Addis Ababa, Ethiopia.

FDRE 2003 Labour law. Proclamation No. 377/2003. Negarit Gazette, Year 10th No.12. Addis Ababa, Ethiopia.

FDRE 2004, Appropriation of Land for Government Works and Payment of Compensation for Property. Proclamation No. 401/2004, Negarit Gazette, Addis Ababa, Ethiopia.

FDRE 2004, The Criminal Code of FDRE. Proclamation No.414/2004, Negarit Gazette, Addis Ababa, Ethiopia.

FDRE, 2011. Proclamation No. 721/2011. Lease holding of Urban Lands.NegaritGazeta.

FDRE 2005, Expropriation of Landholdings for Public Purposes and Payment of Compensation. Proclamation No. 455/2005, Negarit Gazette, 11th year, No.43, Addis Ababa, Ethiopia.

FDRE 2005 Expropriation of Land Holdings for Public Purpose and Payment of Compensation. Proclamation No.455/2005. Negarit Gazette, Year 11, No.43 Addis Ababa, Ethiopia.

FDRE 2005, Rural Land Administration and Land Use. Proclamation No. 456/2005. Negarit Gazette, Year 11, No. 44. Addis Ababa, Ethiopia.

FDRE 2006, labour law(amendment). Regulation No.496/2006, Negarit Gazette, 12th year, No.30 Addis Ababa, Ethiopia.

FDRE 2007, Sold Waste Management. Proclamation No. 513/2007, Negarit Gazette, 13th year, No.13, Addis Ababa, Ethiopia.

FDRE 2007, Payment of Compensation for Property Situated On land holding Expropriated for public purpose. Regulation No.135/2007, Negarit Gazette, 13th year, No.36 Addis Ababa, Ethiopia.

Oromia Regional State Proclamation No. 130/ 2007. Proclamation to amend the proclamation No. 56/2002, 70/2003, 103/2005 of Oromia Rural Land Use and Administration.

FDRE 2010, Leather Development Institute. Regulation No. 181/2010, Negarit Gazette, No. 28 Addis Ababa, Ethiopia.

FDRE, 2011, Urban Lands Lease Holding. Proclamation No. 721/2011. Negarit Gazette, Year 18, No. 4. Addis Ababa, Ethiopia.

FDRE 2013, Food, Beverage and Pharmaceutical Industry Development Institute. Regulation No. 287/2013, Negarit Gazette, No. 44 Addis Ababa, Ethiopia.

FDRE 2019, Expropriations of land holdings for public purposes, payment of compensation and resettlent of displaced people. Proclamation No. 1161/2019, Negarit Gazette, No. 90 Addis Ababa, Ethiopia.

FDRE 2020, Expropriation and valuation, compensation and resettlement. Council of ministers, Regulation No. 472/2020, Negarit Gazette, No. 61Addis Ababa, Ethiopia.

Ethiopian Investment Board Amended Regulation No.1/1997; Regulation" Customs duty free Vehicle Allowance Conditions "Ethiopia Investment Board Proclamation No. 280/94 amended article 29(3) and article 9

EPA , 2003; 2005, State of Environment Report for Ethiopia. Addis Ababa, Ethiopia.

FDRE 1975, Government Ownership of Urban Land and Extra Houses. Proclamation No. 47/1975. Negarit Gazeta Year 34, No. 41. Addis Ababa, Ethiopia.

FDRE 1995, Constitution of the Federal Democratic Republic of Ethiopia. Proclamation No. 1/1995. Negarit Gazeta. Year 1 No.1.Addis Ababa, Ethiopia.

FDRE 1997, Ethiopia Environmental Policy. Environmental Protection Authority in collaboration with Ministry of Economic Development and Cooperation, Addis Ababa, Ethiopia.

FDRE 2000, Ethiopian Water Resources Management. Proclamation No. 197/2000,6th year, No.25, Addis Ababa, Ethiopia.

FDRE 2002, Environmental Pollution Control. Proclamation No. 300/2002, Negarit Gazeta, 9th Year, No.2. Addis Ababa, Ethiopia.

FDRE 2002, Environmental Impact Assessment. Proclamation No. 299/2002, Negarit Gazeta, 9th Year, No 11. Addis Ababa, Ethiopia.

FDRE 2002, Environmental Protection Organs Establishment Proclamation. Proclamation No. 295/2002 Negarit Gazeta, 9th Year, No.7. Addis Ababa, Ethiopia.

FDRE 2002, Re-enactment of Urban Lands Lease Holding. Proclamation No.272/2002. Negarit Gazeta,Year 8, No. 19. Addis Ababa, Ethiopia.

FDRE 2003 Labour law. Proclamation No. 377/2003. Negarit Gazeta, Year 10th No.12. Addis Ababa, Ethiopia.

FDRE 2004, Appropriation of Land for Government Works and Payment of Compensation for Property. Proclamation No. 401/2004, Negarit Gazeta, Addis Ababa, Ethiopia.

FDRE 2004, The Criminal Code of FDRE. Proclamation No.414/2004, Negarit Gazeta,Addis Ababa, Ethiopia.

FDRE 2005, Expropriation of Landholdings for Public Purposes and Payment of Compensation. Proclamation No. 455/2005, Negarit Gazeta, 11th year, No.43, Addis Ababa, Ethiopia.

FDRE 2005 Expropriation of Land Holdings for Public Purpose and Payment of Compensation. Proclamation No.455/2005. Negarit Gazeta, Year 11, No.43 Addis Ababa, Ethiopia.

FDRE 2005, Rural Land Administration and Land Use. Proclamation No. 456/2005. Negarit Gazeta. Year 11, No. 44. Addis Ababa, Ethiopia.

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