Towards Sustainable Development by New Town Planning- Case Study of Mazandaran Province of Iran

Vom Promotionsausschuss der
Technischen Universität Hamburg
zur Erlangung des akademischen Grades

Doktor Ingenieur (Dr.Ing.)

genehmigte Dissertation

von
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aus
Teheran (Iran)

2019

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Tag der mündlichen Prüfung: 14. Juni 2019

Herausgeber/Editor: Gesellschaft zur Förderung der Forschung und Entwicklung der Umwelttechnologien (GFEU) an der Technischen Universität Hamburg e.V.

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ISBN: 978-3-942768-24-5

Hamburger Berichte zur Siedlungswasserwirtschaft Band 99

Acknowledgments

Doing a PhD, sometimes feels like a lonesome journey, but I have been surrounded by wonderful people who have contributed to this work and has given enormous support during this course of my academic career.

I am deeply thankful to my supervisor and promoter Prof. Dr.- Ing. Ralf Otterpohl for excellent remarks and input during my PhD period. I appreciate all the time you devoted to our fruitful discussion during last four years.

Thanks to all my colleagues at the Institute of Wastewater Management and Water Protection at TUHH, Joachim Behrendt, Ina Körner, Dorothea Rechtenbach, Christoph Ohlrogge, Stefan Deegener, Moses Kolade Ogun, Sreenivasan Ramaswami, Ruth Schaldach, Jessica Schermuly, Tavseef Shah, Jan Robert Wibbing, Caroline Ajonina, Tina Carmesin, Susanne Eggers, Binnur Kuscu, Andreas Wiebusch, Dirk Manns, Anna Deipser, Lukas Huhn, Rahel Birhanu Kassaye, Asrat Mindachew Yemaneh, Leonardo Leyva Amezcua, Rožle Lavrač, Jairo Dario Melo Pineda, Torsten Bettendorf, Horacio S. Factura , Josep De la Trinxeria, Mamadu Boy Bari, Eva Petersen, and Gisela Becker.

I am grateful to Noushin Khazaei, my colleague and great friend. It has been wonderful and indeed very fruitful for me to have you around. I appreciate all the time we have spent for discussing different scientific matters. Thanks for all your support and the effort you are already putting as my close friend.

I would like to greet Dr. Ali A. Jahangiri, Managing director of the Kandelous Agro-Industrial Group Company and local people of the Kandelous village who participated in face to face interviews.

Thanks for proofreading to Dr.-Ing. Ali Moghadasi, Holger Gulyas, Jens Tesmer, and Jaani Mikael Hintikainen.

My deepest gratitude goes to my family for their unconditional love. My kind father whose compassion and determination to be human will stay in my memory, my mother, whose devotion and support has given me the strength in the roughest times during my PhD and beyond, my dear sister, whose love and honest opinions has always warmth my hearth and helped me to keep in the track.

Abstract

The New Town planning concept was evaluated as an alternative solution for regulating imbalanced urban-rural growth in the Mazandaran province of Iran. The research was conducted in three main aspects. Firstly, local development through creation of small-scale enterprises with low-tech solutions was studied by analysing several small-scale businesses. Secondly, human well-being assessment was conducted in the Kandelous village by considering housing, earning and job, work-life balance, education, environmental quality, health, civic engagement and governance, personal security, social connections, happiness, and life satisfaction topics. Thirdly, the study area was assessed to identify suitable place for creating *New Town* settlement by using an integrated GIS-AHP technique that was followed by a validation step using high resolution Google Earth images and a field study survey.

It was found that small-scale business with low-tech solutions can support a suitable quality of life for local people including a suitable work-life balance. However, this balance is highly depends on management skills rather than size of business. In all studied cases, a strong link between business and social development was identified. In all described cases several socio-economic-environmental achievements were detected that are useful for application in other villages.

The conducted human well-being assessment in the Kandelous village shows that the surveyed people are happy and satisfied from their life in the village. Moreover, we have detected high well-being status in different topics such as social connections, civic engagement, work-life balance, health, employment rate, and environmental quality. Thus, small-scale settlements can not only play a role in ecological functionality of the region but also can offer an attractive life for people. However, expectations of people about life have a key role in the life satisfaction of people.

The LSA assessment indicated that 163.29 Km^2 (0.68%) of the study area is highly suitable for creation of *New Town* settlement. While 2,418.79 Km^2 (10.15 %) is moderately suitable, 2,749.06 Km^2 (11.53 %) is marginally suitable land, 1,931.86 Km^2 (8.10 %) is currently not suitable, 28.38 Km^2 (0.12%) is permanently unsuitable. Slope was identified an important topographical restriction factor in the proposed decision support model, whereas approximately 53.25% of total area was classified as very steep area (30-500 degree). The distribution of existing farms among the suitability classless was determined in 2,400 Km^2 that were randomly selected. The obtained visualization results show that approximately 94 percent of highly suitable, 78 percent of moderately suitable, and 16 percent of marginally suitable lands were used for agricultural activities.

At a county level, Miankaleh, Miyandorodbozorgh, Roodpayshomali, Kalarastaghgharbi, and Golijan counties were determined as the most suitable places for *New Town* development, whereas about 86.80% of highly suitable lands (141.73 Km^2), 14.07% of moderately suitable lands (340.47 Km^2), and 3.02% of marginally suitable lands (88.14 Km^2) are located in these counties. The field study survey was conducted for the Miankaleh County, the results indicate that this county has a unique environmental quality with a rich fauna and flora. From socio-economic analysis, this county has an imbalanced urban-rural growth, whereas a negative growth rate for rural settlements was detected. Besides, low employment rate (22-37%) can be noted as another socio-economic challenge for this county. Although, several opportunities such as unique environmental quality, close distance to the Caspian Sea, and a good logistic access can be considered for creating *New Town* settlements.

Kurzfassung

Das New-Town-Planungskonzept wurde als alternative Lösung zur Regulierung des Stadt-Land-Wachstums in der iranischen Provinz Mazandaran übernommen. Die Forschung wurde in drei Hauptaspekten durchgeführt. Erstens, lokale Entwicklung durch die Gründung von Kleinunternehmen mit Low-Tech-Lösungen. Zweitens, das menschliche Wohlbefinden Beurteilung im Kandelous Dorf durch die Berücksichtigung von Wohnen, Einkommen und Arbeit, Work-Life-Balance, Bildung, Umweltqualität, Gesundheit, bürgerschaftliches Engagement und Governance, persönliche Sicherheit, soziale Zusammenhänge, Glück und Themen der Lebenszufriedenheit, Drittens , das Studiengebiet ist ein guter Ort, um zu gehen. New Town Siedlung mit einer integrierten GIS-AHP-Technik.

Es wurde festgestellt, dass Kleinunternehmen mit Low-Tech-Lösungen eine Work-Life-Balance unterstützen können. Dieses Gleichgewicht ist jedoch eher als die Größe des Geschäfts. In allen untersuchten Fällen, was identifiziert. In all diesen Fällen haben sich mehrere sozioökonomisch-ökologische Errungenschaften als nützlich für die Anwendung in anderen Dörfern erwiesen.

Die begleitete Bewertung des menschlichen Wohlbefindens im Kandelous-Dorf zeigt, dass die befragten Personen glücklich und zufrieden sind. Darüber hinaus haben wir einen hohen Status in verschiedenen Themen wie soziale Verbindungen, bürgerschaftliches Engagement, Work-Life-Balance, Gesundheit, Beschäftigungsquote und Umweltqualität festgestellt. So können kleinräumige Siedlungen nicht nur im Umweltleben eine Rolle spielen. Die Erwartungen der Menschen über das Leben sind jedoch zu einer Schlüsselrolle in der Lebenszufriedenheit der Menschen geworden.

Die LSA-Bewertung ergab, dass 163,29 km^2 (0,68%) des Untersuchungsgebiets für die Schaffung einer Siedlung in New Town sehr geeignet sind. Während 2.418,79 km^2 (10,15%) mäßig geeignet sind, sind 2.749,06 km^2 (11,53%) marginal geeignete Flächen,

1.931,86 km^2 (8,10%) sind derzeit nicht geeignet, 28,38 km^2 (0,12%) sind dauerhaft ungeeignet. Die Steigung wurde im vorgeschlagenen Entscheidungshilfemodell als ein wichtiger topographischer Einschränkungsfaktor identifiziert, während ca. 53,25% der Gesamtfläche als sehr steil eingestuft wurde (30-500 Grad). Die Verteilung der bestehenden Betriebe auf die Eignung klassenlos wurde in 2.400 Km^2 bestimmt, die nach dem Zufallsprinzip ausgewählt wurden. Die erhaltenen Visualisierungsergebnisse zeigen, dass ungefähr 94 Prozent von hochgeeigneten, 78 Prozent von mäßig geeigneten und 16 Prozent von marginal geeigneten Landflächen für landwirtschaftliche Aktivitäten verwendet wurden.

Auf Bezirksebene wurden die Bezirke Miankaleh, Miyandorodbozorgh, Roodpayshomali, Kalarastaghgharbi und Golijan als die geeignetsten Orte für die Entwicklung der Neustadt bestimmt, während etwa 86,80% der sehr geeigneten Gebiete (141,73 km2), 14,07% der mäßig geeigneten Gebiete (340,47 km^2), und 3,02% der am Rande geeigneten Flächen (88,14 km2) befinden sich in diesen Landkreisen. Die Feldstudie wurde für den Bezirk Miankaleh durchgeführt. Die Ergebnisse zeigen, dass dieser Landkreis eine einzigartige Umweltqualität mit einer reichen Fauna und Flora aufweist. Aus der sozioökonomischen Analyse ergibt sich ein unausgeglichenes Stadt-Land-Wachstum, während eine negative Wachstumsrate für ländliche Siedlungen festgestellt wurde. Außerdem kann eine niedrige Beschäftigungsquote (22-37%) als eine weitere sozioökonomische Herausforderung für diesen Landkreis festgestellt werden. Allerdings können verschiedene Möglichkeiten wie einzigartige Umweltqualität, die Nähe zum Kaspischen Meer und ein guter logistischer Zugang für die Schaffung von Siedlungen in der Neustadt in Betracht gezogen werden.

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Abbreviations and symbols

AHP	Analytic hierarchy process
BMO	Business Model Ontology
CI	Consistency Index
DEM	Digital elevation model
E	East
FAO	Food and Agriculture Organization of the United Nations
GDPR	Gross Domestic Product per Region
GIS	Geographic information system
GMOs	Genetically modified organism
I_{DM}	Aridity Index of De Marttonne
IDW	Inverse Distance Weighted
IFOSM	International Federation of Organic Agriculture Movements
IOA	Iranian Organic Association
ISA	Iranian Space Agency
ISSA	Iranian Scientific Society of Agroecology
KAIG	Kandelous Agro-Industrial Group
KCL	Kandelous Cultural Institute
KML	Keyhole Markup Language
LSA	Land suitability assessment
LULC	Land use-Land cover map
MCDM	Multiple-criteria decision-making
N	North
NGO	Non-Governmental Organization
NCC	National Cartographic Centre of Iran
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
S	South
SADRA	Iran Marine Industrial Company
SRTM	Shuttle Radar Topography Mission

UN	United Nations
UNDP	United Nations Development Programme
UNEESCO	United Nations Educational, Scientific and Cultural Organisation
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VAT	Value added tax
W	West
WOA	Weighted Overlay Analysis

Chapter 1 Introduction

1.1 Background

The world's urban population has grown very fast since 1950, from 746 million to 3.9 billion in 2014. In addition, about 7 billion people (around 70 percent of global population) is expected to live in urban areas by 2050 (UN Department of Economic and Social Affairs, 2014). This rapid urbanisation will be resulted in more concentration of people in already crowded cities, whereas several socio-economic-environmental problems are reported in urban areas including traffic congestion, air pollution, shortage of housing, unemployment, middle-class squeezing, poverty, and inadequate infrastructures and services (New York City Council, 2013; Akahori, 2014; Denoeux, 1993; Putnam**;** 2001; Block et al., 2015). In addition to the aforementioned problems, several ecological issues such as land degradation, deforestation, climate change, and desertification, will impose more pressure on ecological capacity to deal with this rapid population growth. Traditionally, urban area has been recognized as dense central business activities, mainly in services sectors, where usually rural area is ignored to be a good place to live and work. The role of rural area in the context of sustainable development should be highlighted where agriculture is the primary economic sector in most rural areas and several environmental goods and services are provided from these areas. While, life will be endangered without these goods and services. Thus, to regulate urban-rural growth, innovative approaches, such as *New Town* planning, are highly demanded to make a balance between ecological capacities, economic development, and human well-being in urban and rural settlements.

1.2 Concept of New Town-planning

The *New Town* is a new planning concept for regional development with a focus on interconnections between town and urban settlements. This concept was introduced by Professor Ralf Otterpohl at Hamburg University of Technology in 2013 (Otterpohl, 2013), whereas a short description is present in the following of this section.

The *New Town* planning concept proposes an integrated rural-urban planning framework with considering socio-economic-environmental conditions (see Figure 1-1). The *New Town* planning emphasizes on local production through innovative solutions, whereas maintaining the ecological capacity along with a suitable life quality (including freedom, work-life balance, and housing) are considered in planning procedure. The *New Town* planning concept suggests communities between 50 up to 200 part time poly-productive micro-farms and up scaling can lead to a sort of a garden ring around cities, as shown in Figure 1-1. In addition, soil quality is considered as a key production factor for farming that has a direct influence on environmental goods and services (e.g. water, food, and energy). Besides, *New Town* planning concept seeks for food self-sufficient, energy-cost efficient along with a suitable housing for local people. Thus, this concept can be noted as sustainable communities for sustainable development, whereas successful small-scale enterprises play an important role to solve environmental-societal problems. Further details about this concept can be found in (Otterpohl, 2016, 2017).

The New Town planning concept has some similarities with the Garden City movement that was introduced by in 1898 by Sir Ebenezer Howard in the United Kingdom. First, a balance regional distribution of people is considered in both approaches. However, the Garden City can be acknowledged as settlements in suburban area to provide an alternative settlements for the working class. While the New Town planning concept suggests smaller agro-based communities with a focus on ecological sustainability. Second, both

concepts suggests a cluster of towns system. Third, both concepts can be noted as green-oriented town planning, whereas greenbelt was considered in planning as an important element.

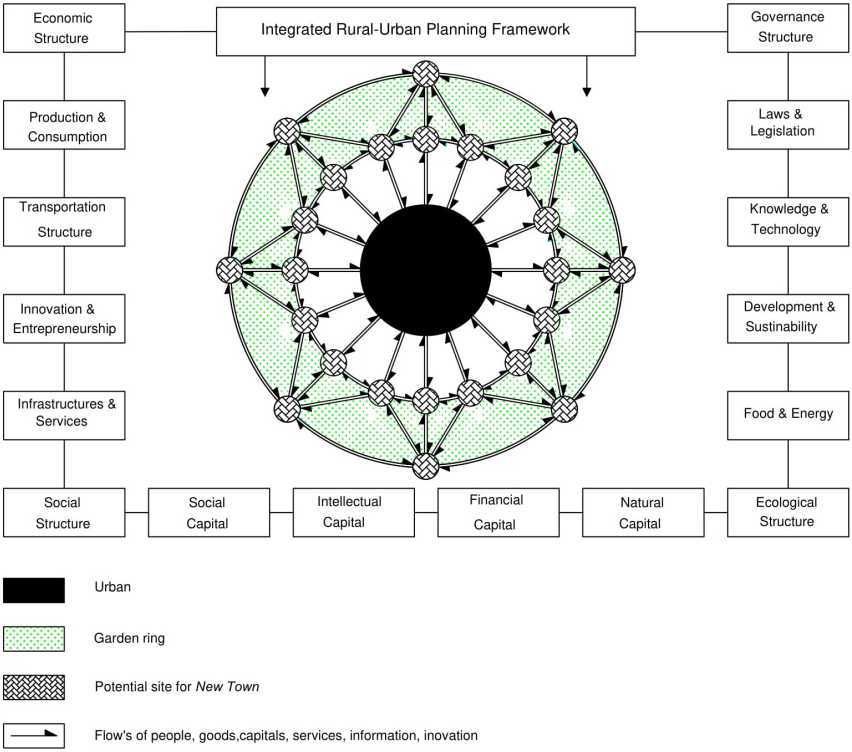

Figure 1-1 Iintegrated Planning framework in *New Town* concept

1.3 Study area

The study was carried out in the Mazandaran province of Iran, located along the southern coast of the Caspian Sea (see Figure 1-2). The study area is situated between the latitude 35°47' to 36°35'N and longitude 50°10' to 54°10'E, covering an area of 23,841 Km². This

area is approximately 1.47 percent of the total Iranian territory. According to the last census records (was conducted in 2010), the study area's population was counted to 3,073,943 people within urban-rural settlements including 57 towns, 119 counties (see Appendix 1), and 3346 villages.

The population density rate in the Mazandaran province was reported as 129 persons per Km^2 for the year 2011 (Statistical Centre of Iran, 2011). Several languages can be identified in the region namely Mazani, Gilaki, Farsi, Turkish, Kurdish, Baluchi, and Russian. However, the main spoken language of the study area is Mazani, which is one of the longest written traditions, from the tenth to the fifteenth century.

Figure 1-2 Location of the Mazandaran province of Iran

The terrain of the study area is divided into two main types: the coastal plains, and the mountainous areas. While the elevation level in the study area varies approximately from -80 to 5,604 m (extracted from the digital elevation model). The Alborz Mountain Range surrounds the coastal strip and plains of the Caspian Sea. As a result of this geological condition, a significant difference exists in the region in

terms of degree of slope, soil type, vegetation cover, and climate. As an example to this, the temperature of the study area ranges from -15 – 36.5 °C in summer, and between -20 – 25 °C in winter (Statistical Center of Iran, 2010). Although snow may fall heavily in the mountains in winter, it rarely falls at sea level. Therefore, the climate of the province can be classified into three types: moderate Caspian weather with hot, humid summers, and mild, humid winters. Moderate mountainous weather with long, cold, and freezing winters and mild and short summers, and cold mountainous weather with long freezing winters and short cool summers. The soil of the region is broadly varied, depending on geology, slope, elevation, and vegetation cover.

The economy of the Mazandaran province has a strong link to agricultural activities, whereas agricultural produces in this province contributes to about 23.05 percent of the Gross Domestic Product per Region (GDPR) for the years 2010/2011 (March 2010−March 2011). Moreover, the study area was ranked as the first agricultural producer among all provinces of Iran (Ministary of Interior of Iran, 2013). The main agricultural products in the region have been reported as rice, wheat, barley, corn, cotton, tobacco and tea plant. The availability of water (e.g. rainfall and surface water), arable lands, and relatively close distance to Tehran (as the biggest city in Iran) can be listed as the reasons for these agricultural prosperities compared to other provinces of Iran. In spite this fact, the agricultural sector contributes to around 21 percent of the total employments (e.g. 29,736 job opportunities in all sectors), whereas the service and industrial sectors allocated around 79 percent of the total employments in the study area. Since the province has around 330 Km coastlines, the study area is one of the touristic magnets as a recreational area in the northern part of Iran, whereas the hospitality industry's capacity has been expanded to 23,414 persons per night (includes 174 five stars hotels, 730 four stars hotels, 798 three stars hotels, 700 two stars hotels, and 525 one star hotels) in the years 2010/2011 (March 2010−March 2011). The region has the basic infrastructures in many rural points namely water supply system (100 percent coverage in all villages),

electricity (89 percent coverage in all villages, the annual capacity for generating electricity by thermal-gas power plants is about 2,265 MW with 38 percent free operational capacity), gas supply facilities (34 percent coverage in all villages), asphalted roads access (about 50 percent of total rustic roads), and the internet coverage (100 percent in all villages). Several public transportation facilities exist in the study area namely 3 airports, 14 railway stations (430 Km railway lines), 5 ports, all together with 180 transportation companies (with a capacity of 230 buses, 58 mini-buses, 11,740 taxies) (Statistical Center of Iran, 2010).

1.4 Problem statement

An imbalanced rural-urban growth in the study area can be highlighted with a significant reduction of rural population ratio. As shown in Figure 1-3, around 80 percent of total population was reported for rural settlements in the year 1956 and this ratio has declined to about 45 percent in the year 2011 (Statistical Center of Iran, 2011). In other word, cities in the study area are developed as big magnates for regional growth while cities have to deal with this rapid urbanization rate. In spite of this fact, several other socio-economic-environmental issues for urban development are acknowledged as water pollution, disposal of municipal solid wastes, and along with lack of job opportunities. Thus, sustainability of the region has to solve all aforementioned challenges to obtain a balance urban-rural growth in a more sustainable approach.

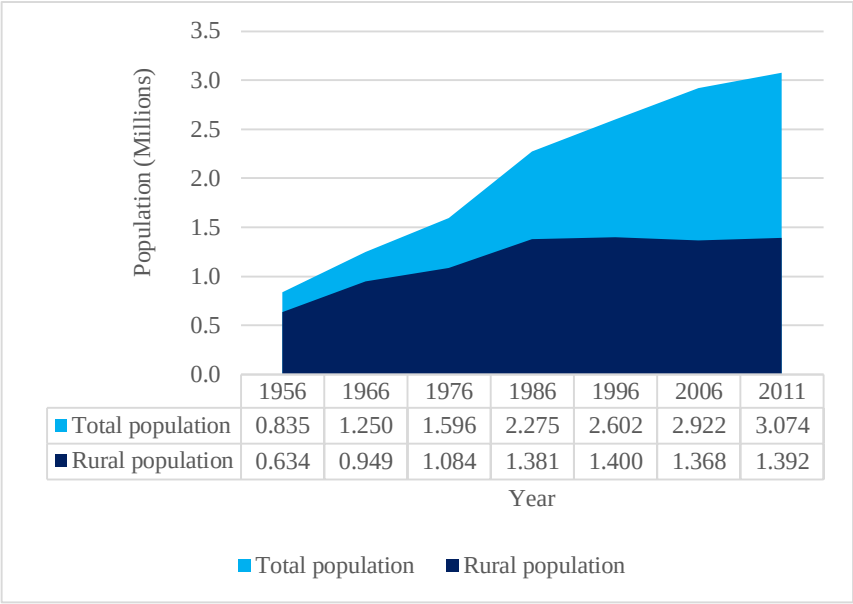

Figure 1-3 Trend of population growth in the Mazandaran province of Iran (Extracted from Statistical Centre of Iran, 2011)

1.5 Research questions

The questions addressed in this study related to rural planning and sustainable development are as follow:

- How and in which ways creation of small-scale enterprises can influence on local development?
- Can a small-scale business support a suitable quality of life?
- Can a rural area be an attractive place to live?
- Can a rural area offer a suitable life quality for people?
- Which places in the Mazandaran province of Iran are more suitable for establishing *New Town*?

1.6 Hypothesis

The *New Town* planning concept in the Mazandaran province of Iran can play an important role to make a balance between urban and rural growth if it incorporates socio-economic-environmental aspects into an integrated system as a whole. The aim of this study is to analysis potentials in the study area for creation of *New Town*.

1.7 Objectives

The overall focus of this study is to investigate the role of small-scale entrepreneur's community in sustainable development for the Mazandaran province of Iran. The followings aspects were investigated as the main objects:

- Rural development through creation of small-scale enterprises with a focus on low tech solutions
- How's life in rural area?
- Land suitability assessment

The first objective of the present study was conducted by analysing small-scale enterprise cases with a focus on application of low tech solutions. This analysis was followed by a field study (Kandelous Agro Industrial Group) in the Mazandaran province of Iran. The second objective of this study was carried out by development a framework for assessment of life quality for rural area. This was followed by analysing a case study (Kandelous village) in the Mazandaran province of Iran. The third objective of this research was approached by using an integrated AHP-GIS technique. This assessment was developed based on a multi-criteria decision making process and an expert survey, which was implemented in a GIS model. Besides, high resolution satellite image was used in the visualization step to evaluate the obtained LSA's results. Afterwards, the most suitable county was analysed through a field study survey.

1.8 Structure of research

The scheme of present study is shown in Figure 1-4. Literature research is presented in **Chapter 2**, where reviews of important topics related to this study are discussed. The influences of several small-scale enterprises on local development are analysed in **Chapter 3**. While **Chapter 4** develops a framework for assessment of life quality in rural settlements. This assessment is followed by using the Kandelous village as a field study in the Mazandaran province of Iran. **Chapter 5** deals with land suitability analysis for creating *New Town* using AHP and GIS techniques. Conclusion and outlook are presented in **Chapter 6**.

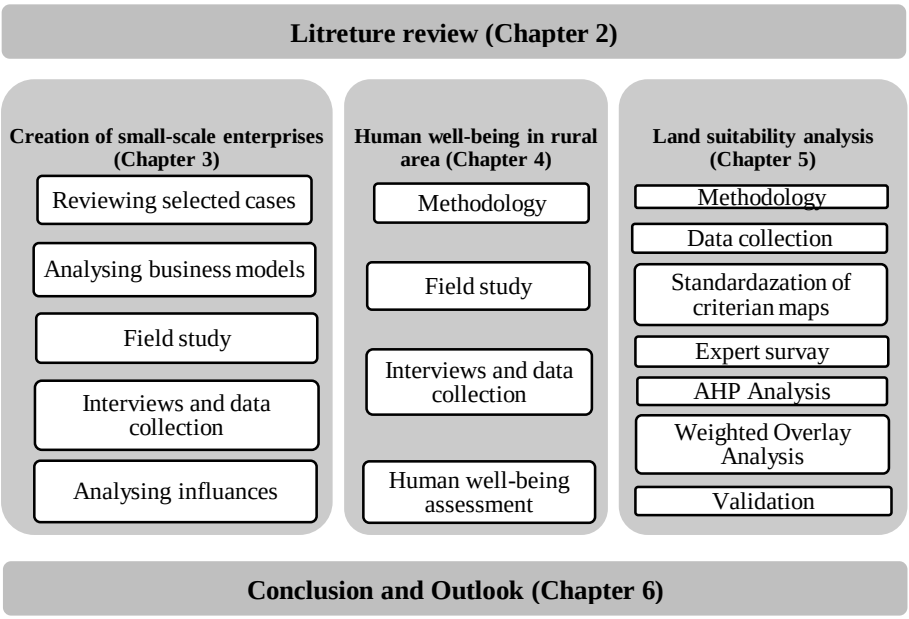

Figure 1-4 Scheme of the research structure

Chapter 2 Literature review

2.1 Introduction

In this Chapter different aspects relevant to the study are presented based on literature research. A short overview about development, sustainability, rural area, and entrepreneurship concept, human well-being, organic farming, and land suitability analysis for organic farming using AHP and GIS techniques are included in the review.

2.2 Definition and dimensions of development's concept

Several definitions can be detected from literature to address development's concept. Among of them, UNDP definition (UN Development Programme, 1991) could stand out as a comprehensive one's. It suggests "*expanding the range of choices for the population that allows development to become more democratic and participative (...) access to (sic) income... participation in decisions and enjoyment of human, economic and political liberties*". Considering the aforementioned definition, development define as a process that should contain three main elements which listed below (FAO, 1985a; UN Development Programme, 1991).

- **Economic:** The provision of the economic sector, which will produces the required goods and material for life
- **Social:** The development of different social amenities and services (i.e. health, education, welfare) that is required for the non-productive needs of a society.
- **Human:** The development of the people (individuals and communities), to understand their full potential, to implement their talents and skills, and to have a constructive part in shaping their own community.

Development has to deal with the aforementioned elements in an integrated approach, whereas development should not concentrate upon one element to the exclusion of the others elements (Zahedi & Otterpohl, 2015). Moreover, development plan should adapt through the sustainability concept which will be explained in the following of this Chapter.

2.3 Definition and dimensions of sustainability's concept

The term "sustainability" as defined by the Brundtland Commission, the World Commission on Environment and Development, calls for meeting the needs of the current generation while preserving the ability of future generations to meet their needs (UN World Commission on Environment and Development, 1986). Thus, based on the aforementioned definition, understanding human needs can be pointed as the first step in this concept. According to a group of researchers, under A Latin American World Model, most of humankind subscribes to prosperity, justice and ecological sustainability goals. As shown in Figure 2-1, the aforementioned goals are known as global ethical trilemma, whereas achieving these points is a challenge that is hard to confront.

The corners of the triangle correspond to the three components often included in the dimensions of sustainable development: the ecology (sustainability), the economic (prosperity) and social (justice) dimensions. Eco-efficient capitalism, Global social democracy and Reed-green planetarisim (i.e. sides of the triangle in Figure 2-1) are schools of thought which only took two corners. Each corner is briefly explained in the following of this Section.

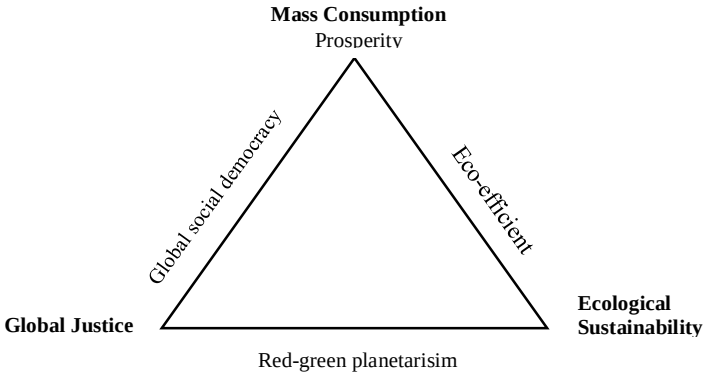

Figure 2-1 Global ethical trilemma (Eriksson & Andersson, 2010; Herrera, 1976)

2.3.1 Ecological sustainability

The term sustainability has its roots in ecology as the ability of an ecosystem to maintain ecological process, functions, biodiversity, and productivity in the future. To be sustainable, nature's resources must only be used at a rate at which they can be replenished (Zahedi & Otterpohl, 2015). Sustainability could measure through different ways such as ecological footprint, sustainable economic welfare, the genuine process indicator, maintaining production opportunity, non-declining natural capital, maintenance of sustainable yield of resource service and global consensus (Eriksson & Andersson, 2010).

2.3.2 Prosperity

The history of economic development during the period of 1950−1973, as the Golden Age of economic growth among countries in Western Europe and Japan, indicates that economic growth is interconnected with mass consumption society (Eriksson & Andersson, 2010). According to Rostow's stage theory, the mass consumption society constitutes of the end goal humanity whereas,

the final stage of prosperity is mature mass consumption stage (Rostow, 1991).

2.3.3 Global justice

This concept seeks for achieving and maintaining a desire life quality among people. Therefore, the global justice can be noted as an international concept to reduce the gap between developed and developing countries. As an international attempt, the human rights declaration adopted by the United Nation in 1948 marks the breakthrough of the quest of global justice (United Nations General Assembly, 1948). The results of a research show that a huge gap exist between rich and poor countries, for example income level is about 70 times higher in North (i.e. the richer countries which are mainly in Europe, North America, and parts of East Asia) countries (Hedenus & Azar, 2005).

2.4 Definition of rural area

The term “rural” was applied to classify geographical space, whereas rural settlement is acknowledged as a geographic area that is located outside urban. Thus, the difference between rural-urban typology can be viewed as an approach to identify rural settlements, whereas this difference can be highlighted through following criteria:

- **Size of population:** rural settlement is smaller than urban settlement
- **Population density:** number of inhabitants per unite of area in rural is smaller compared with urban settlement
- **Occupation:** farming and agriculture are the major economic sectors in rural area, whereas industry and services are the main economic sectors in urban area

- **Closest to natural environment:** rural area offers more direct connection with natural environment such as soil, forest, water bodies, and animals

Since the differences between urban and rural areas are dependent on contexts, each country has its own definition for identifying rural settlements, as some of these definitions are present in Table 2-1. Population size, population density, and employment ratio in agriculture have been used as indicators to identify rural areas. However, in some countries, such as the U.S. and Japan, rural area has not defined in spatial classifications. In spite of lack of definition in these countries, the term rural has used in these countries to address settlements that is located outside city boundaries. Besides, the ratio of employment in agriculture is a key indicator to distinguish rural area. In some countries such as India, all aforementioned indexes have been used to recognize rural area. In Iran, the term rural is acknowledged as the smallest territorial unit. Population size and the ratio of employment in agriculture are considered by Statistical Center of Iran to classify the region, whereas rural defined as "settlement with less than 5,000 people, whereas the major job opportunities are provided by agricultural sector". Thus, based on the aforementioned definition in the study area, rural area can be noted as a small-scale settlement with an Agro-based economy structure.

Table 2-1 Applied criteria among countries for identifying rural settlements

Country	Main criteria	Description	Ref.
Canada	Population size	Maximum 1,000 people	(Statistics Canada, 1999)
	Population density	Maximum 400 people per sq Km	

Country	Main criteria	Description	Ref.
Mexico	Population size	Less than 2,500 people	(National Institute of Statistics-Geography and Informatics of Mexico, 2010)
India	Population size	less than 5,000 people	(Office of the Registrar General & Census Commissioner, 2011)
	Population density	less than 400 per sq Km	
	Working content	More than "25 percent of the male working population" is engaged in agricultural activities.	
Scotland	Population size	Less than 3,000 people	(Scottish Government, 2016)
Japan	In contrast to urban area	Urban defined as “an area with over 5,000 people, which consists of each district with a population density of over 4,000 per square kilometer”	(Satori & Agung, 2017)
U.S.	In contrast to urban area	Two definitions are available for urban area as: 1) Urbanized Areas (UAs) of 50,000 or more people; 2) Urban Clusters (UCs) of at least 2,500 and less than 50,000 people.	(Ratcliffe, Burd, Holder, & Fields, 2016)
OECD	Rural community	Less than 150 per sq Km	(OECD, 1994)
Iran	Population size	Less than 5,000 people	(Statistical Center of Iran, 2011)
	Working content	More than 50 percent of total employment is provided by agricultural sector	

2.5 Definition and dimensions of entrepreneur's concept

The term "entrepreneur" is a loan word that was taken from an old French expression "entreprendre", which simply means "to undertake". In economic literature, this term first was used by Richard Cauntillion in 1730 and later by Jean Baptiste Say in his treatise on Political Economy (1803). While, Jean Baptiste Say broadened the definition to include the concept of bringing together the factors of production (W. W. Gasparski, 2010), whereas three factors in the classical economics are distinguished as land, labor, and capital (Zahedi & Otterpohl, 2015). However, in modern economy several types of capital are considered as natural capital, manufactured capital (i.e. manmade equipment, building and infrastructure), human capital, intellectual capital (i.e. discoveries, innovations and scientific results), social capital (i.e. trust, mutual understanding and shared value), and financial capital (Eriksson & Andersson, 2010). Schumpeter defined the entrepreneurs as "the inventor who implements change within markets through carrying out of new combinations ". Schumpeter considered several forms for changing market as listed below (Ahmad & Seymour, 2008; Schumpeter, 1934, 2008).

- The introduction of a new good or quality thereof
- The introduction of a new method of production
- Opening a new market
- The conquest of a new source of supply of new materials or parts
- The carrying out of new organization of an industry

After Schumpeter's work, innovation became a part of definition of entrepreneur word. Therefore, entrepreneurial spirit is characterized by innovation and risk-taking. At least thirteen distinct roles for the entrepreneur can be identified in economic literature [16, 21−24] such as an allocator of resources among alternative uses. Table 2-2 shows the entrepreneur concept's definition and transition of this concept

through the time (Kao, 1993; McMullan & Long, 1990; Schumpeter, 1934; Thornton & Flynn, 2003; Zahedi & Otterpohl, 2015).

Table 2-2 Dynamic changes in entrepreneur concept's definition (Kao, 1993; McMullan & Long, 1990; Schumpeter, 1934; Thornton & Flynn, 2003; Zahedi & Otterpohl, 2015)

Authors	Description
Cantillon; 1730	Entrepreneurship is self-employment with an uncertain return. Cantillon recognized three classes of economic agents: landowners, entrepreneurs and employees.
Baudeau; 1767	Entrepreneurship is innovative management
Say; 1803	Described entrepreneur as an extraordinarily talented manager
Menger; 1871	Differentiated entrepreneurial decision-making into four sequential stages
Marshall; 1890	Hinted at a distinction between entrepreneurs and managers
Shumpeter; 1910	Described the entrepreneur as an innovator, carrying out new combinations
Lebenstein; 1970	The reduction of organizational inefficiency and at the same time reversal of organizational entropy
Adam; 1989	An entrepreneur is a person whose business actions make him/her a leader in the economic world especially when results in industrial growth or technical advanced
Kao; 1993	Process of doing something new and something different for the purpose of creating wealth for the individual and adding value to society
Thornton & Flynn; 2003	Discovery and exploitation of opportunities and creation of new organization, which occurs as a context-dependent social and economic process
Zahedi & Otterpohl, 2015	The art of using land, labor, natural resources, technology and capital which can produce profit and added value in a society

2.6 Definition and dimensions of human well-being's concept

Human well-being can be viewed as an ambiguous concept among scholars in different subjects such as philosophy, sociology, health sciences, and psychology (Camfield, L., McGregor, 2005; Schmidt, S. , Bullinger, 2007), while more than 100 definitions for its meaning can be detected in literature (Alcamo & Bennett, 2003; Andereck & Nyaupane, 2011). Despite the lack of a universal agreement for well-being definition, some main fundaments can be recognized from literature as follow. First, well-being is not an issue which only wealthy people can aspire to, but even in a very difficult circumstances, the quality of life matters. Therefore, most of people have ambitions for themselves and their children to live better lives. Second, multi-dimensional aspects are involved in our well-being, as shown in Figure 2-2, including material of life, heath, social connections, security, and along with freedom to choose (Millennium Ecosystem Assessment, 2005). Third, this concept must be understood as "to *live well together with others"*, whereas the *telos* to *"live well as an individual" will* be a threat to the social aspect of our life.

An essential step in human well-being assessment can be understanding mankind's needs, whereas two main streams among scholars should be highlighted. First, *Basic Need* movement, who have a focus on primary needs such as income, food, water, shelter, and clothes. This school of thought try to combat poverty across nations, where the materials of life have been acknowledged as important and ignorable part of our well-being (UN Department of Economic and Social Affairs, 2015; World Bank, 2000). Second, the rest of scholars mainly have more complex formulations and desires about human needs, whereas according to Maslow's "hierarchy of needs", physiological needs are placed at the base of a pyramid and other high order needs have a critical role in our life namely safety, belongingness and love, esteem, and self-actualization.

To some extent, the notions of human well-being is old as civilization history, whereas some trace of that back to Anstotle era (McGregor, 2014). More recently, and after a significant evolution in measuring subjective aspects of life in happiness, this concept has taken renewed interests among researchers and policy makers (Layard, 2005). Happiness approach to determine subjective aspects of life, has had a great influence in capturing such as important domains by cognitive assessments of life satisfaction and affective evaluations of emotions and moods (Argyle, 2001; Eid & Diener, 2004). Thus, mainly it has been accepted among researchers that a multi-dimensional approach, including economic measures, for well-being assessment is required. However, on governance side, there have been long-term debates among decision makers about what human needs must be considered in developmental progress for a good life (McGregor, Camfield, & Woodcock, 2009).

The main goal of economic and societal development can be viewed as means of improving human well-being (United Nations General Assembly, 1986). Thus, sustainable development from this perspective is acknowledged as a harmony between mankind's needs and planet Earth to achieve a good level of well-being both in present and future. Internationally, three important attempts have been taken in order to capture multidimensional of human wealth in a national scale. Since 2004 and under United Nations Development Program framework, Human Development Index has been applied to capture three key aspects of life including health (i.e. life expectancy as a representative here), education, and income (i.e. GDP). After 2010, one more environmental parameter (i.e. CO_2 emission) has been added to this index and its name has been changed to Sustainable Human Development Index. Despite the fact that environmental aspect is considered, still many subjective aspects of life such as happiness is not included in these measures. As the first international attempt to capture these aspects of life, since 2010, every four years, the OECD countries publishing a report entitled "*how's life*", within this report many aspects of life including, health, education, income,

happiness are determined along with environmental measures (OECD, 2011). As shown in Figure 2-2, a link between overall life satisfaction with other aspects of life was considered in the *how's life* report, while overall life satisfaction also can affected from environment.

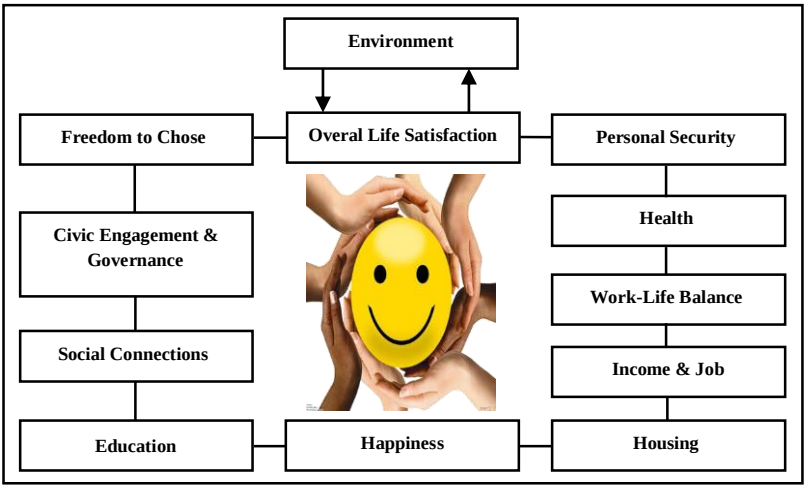

Figure 2-2 Considered aspects in *how's life* report for human well-being assessment

2.7 Definition and dimensions of organic farming's concept

The term "organic farming" first was introduced by Northbourne in his book entitled "*Look to the Land as a forgotten classic*" (Northbourne, 2003; Scofield, 1986). This term was applied in this book to address a community made up of small and self-sufficient farms with an emphasis in the relationship between soil quality, cultivation, food quality, human health, and interdependence of all living things in farmlands (Paull, 2006). Some scholars (Paull, 2006; Rigby & Caâ Ceres, 2001) mentioned that Northbourne was influenced by Dr. Rudolf Steiner (1924), the Austrian Philosopher

who introduced the Biodynamic farming concept. The Northbourne's definition has a major impact on the application of this term among other scholars, whereas some of the collected definitions are described later in this Section.

The US Department of Agriculture (USDA) has defined the term organic agriculture as "an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on the mineral use of off farm inputs and on management practices that restore, maintain and enhance ecological harmony" (USDA, 1995). International Federation of Organic Agriculture Movements (IFOSM) has illustrated the organic agriculture as a production system that sustain the health of soils, ecosystems and people (IFOAM, 2008). This movement has pointed out that the organic agriculture is a combination of tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. FAO (2012) has a more comprehensive definition for organic farming as a holistic system for crops, livestock and fish farming that emphasizes environmental protection and the use of natural farming techniques. The primary goal of organic farming was mentioned in this definition as "to optimize the health and productivity of interdependent communities of soil life, plants, animals and people" (FAO, 2012). Moreover, the FAO definition put emphasise on natural farming methods and modern scientific ecological knowledge to ensure the long-term health and productivity of the ecosystem, enhance the quality of the products and protect the environment. While the application of artificial products (e.g. genetically modified organisms (GMOs) and synthetic inputs (e.g. pesticides, veterinary drugs, additives and fertilizers) should be avoided in the organic agriculture. In this research, the FAO's definition for organic farming was considered for the rest of study. Thus, the organic farming was noted as an integrated cultivation system with respect to people and environment.

2.8 Land suitability analysis for organic farming using AHP and GIS techniques

Land assessment process traditionally has been used, as a part of regional planning, for evaluating a given area for specific type of land use (Khazaei & Azari-Dehkordi, 2008). The main objective of land suitability analysis (LSA) is to assess inherent and potential capabilities, and suitability of a land unit for different purposes (FAO, 1976; Pramanik, 2016). The concept of LSA for agricultural activities was first introduced by the FAO under the "Framework for Land Evaluation" in the year 1976. Nowadays, several guidelines are available for conducting the LSA studies in agricultural practice at different level (FAO, 1983, 1985b, 1996). Commonly, agricultural land use is defined at a specific level for a selected crop. To conduct LSA assessment, several aspects need to be taken as: 1) identification and data collection, 2) analysis and data processing, and 3) mapping stages. The outcomes of land suitability process are a set of suitability categories for organic farming activity.

2.8.1 LSA studies using AHP technique

The Analytical Hierarchy Process (AHP) is a multi-criteria decision making methodology, which was developed to solve a complex problem in to a hierarchy structure regarding to different criteria (Saaty, 2008). As shown in Figure 2-3, the AHP algorithm is based on the relationship of the goal (i.e. here for organic farming), objectives (criteria), sub-objectives, and alternatives. To define these relationships, should several steps are considered in the AHP algorithm by the decision makers and planner as 1) problem identification and research, 2) eliminate infeasible alternatives, 3) develop decision structure, 4) evaluate the factors by making pair-wise relative comparisons, 5) best alternative computation, 6) check and balance of decision, and 7) documentation. The AHP is acknowledged as an effective MCDM approach due to a number of

reasons as 1) flexibility, 2) intuitive appeal, 3) structuring complexity, and 4) possibility to compare qualitative and quantitative criteria (Pohekar & Ramachandran, 2004).

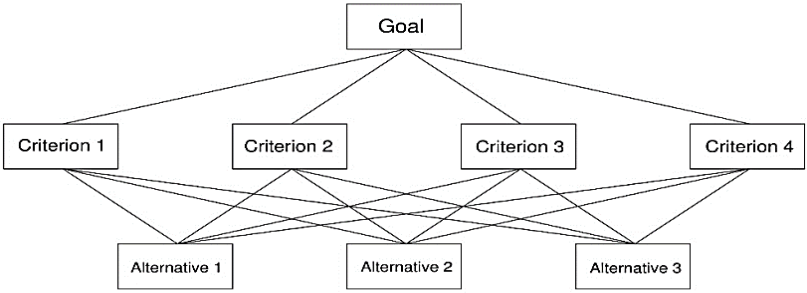

Figure 2-3 Schematic overview of hierarchy structure of AHP

The AHP is widely applied, as a MCDM method, for LSA studies (see Table 2-3). In several studies, the AHP method was combined with ArcGIS software to deal with spatial data (see Section 2.8.2) and land use planning (Pramanik, 2016). As listed in Table 2-3, different criterion maps like climate, topographic, soil type, slope, elevation, aspect, road, river, erosion, and land use maps were used to select the best alternative for agricultural purpose.

Table 2-3 Parameters and data used for agricultural land suitability analysis studies

Suitability field	Method	Criterion maps	Data	Reference
Agricultural land use	AHP-GIS	Land-use, soil depth, erosion hazard, elevation, slope, distance from water source, soil type and road maps	Thematic maps and satellite images	(Bandyopadhyay, Jaiswal, Hegde, & Jayaraman, 2009)
Agricultural land use	AHP-GIS	Land use- land cover, organic matter, soil depth, soil type and slope maps	Thematic maps and satellite images	(Feizizadeh, Jankowski, & Blaschke, 2014)

Suitability field	Method	Criterion maps	Data	Reference
Agricultural land use	AHP-GIS	Land use, soil depth, soil type, erosion, elevation, slope, and aspect maps	Thematic maps and field base data	(Akinci, Özalp, & Turgut, 2013)
Agricultural land use	AHP-GIS	Topographic, land use, land cover, soil moisture, drainage and transport network, and geology maps	Thematic maps satellite images, and DEM	(Pramanik, 2016)
Agricultural land use	AHP-GIS	Topographic, land use, land cover, rainfall, distance to road, and soil type maps	Thematic maps	(Widiatmaka, Ambarwulan, Setiawan, & Walter, 2016)
Agricultural land use	AHP-GIS	Topographic, soil type, towns, roads, rivers, and land cover maps	Thematic maps satellite images, and DEM	(Yalew, van Griensven, Mul, & Zaag, 2016)
Organic farming	AHP-GIS	Topographic, soil type, geology maps, drainage, and land cover- land use maps	Thematic maps	(Mishra, Deep, & Choudhary, 2015)
Rural and agricultural development	AHP-GIS	Topographic, soil type, landslide, seismic intensity map, erosion, drainage, and land cover- land use maps	Thematic maps	(Bathrellos, Gaki-Papanastassiou, Skilodimou, Skianis, & Chousianitis, 2013)

2.8.2 Geographical Information System

The term Geographical Information System (GIS) broadly is applied to geographically oriented computer technology and integrated system. Nowadays, GIS software is acknowledged as a new

information analysing technology in a spatial context, where this technology can offer a new way to view, manage, automate, and analysis spatial data (Gatrell, 1991; Jankowski, 1995). Several applications of GIS have been reported by scholars for decision-making in different fields such as environmental management, urban and regional planning, land use planning, environmental pollution and industrial hazards control, rural and new town planning, and infrastructure management. Thus, GIS system should be noted as a useful tool for LSA studies to process geospatial data. At the following, briefly the spatial data types are described to have a better understanding about GIS system.

In general, two types of spatial data are distinguished for viewing objects in space as vector and raster data (Gatrell, 1991). As shown in Figure 2-4, the vector data use points, lines, and polygons to present an object such as trees, rivers, and land use. While thematic raster data apply arrays of cells (i.e. pixel) to describe a geometric object that exist in a given location. A good illustration of raster data could be the elevation model, whereas each cell shows a vertical elevation value.

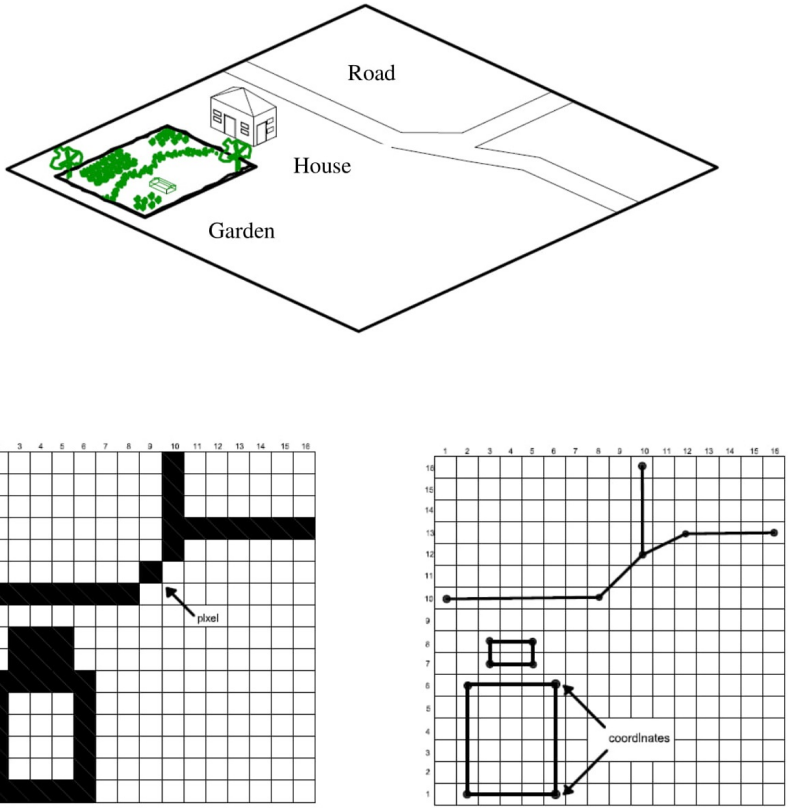

Figure 2-4 Difference between vector and raster data types used in GIS based model

Chapter 3 Creation of small -scale enterprises in the context of sustainable rural development with a focus on low-tech solutions

3.1 Introduction

Creation of small-scale enterprises in rural area interact with sustainability though several channels. On social side, creation of job opportunities are interconnected with human well-being in terms of sufficient income for life, which is recognized as the Achilles heel of a convenient life in rural area (OECD, 2013). On economic side, small-scale businesses (here defined as less than 200 employees) are important components of economic structure, which contribute with economic growth, and gross domestic product. Furthermore, stimulating of rural economy through small-scale enterprises can active local people to be more productive. Moreover, new job opportunities are highly demanded in rural areas, especially in the study area, to tackle unemployment challenge. On environmental side, the vital function of rural area should be highlighted, where several environmental goods and raw materials supply from rural areas to city areas. Thus, protecting of natural resources and maintaining environmental quality should be noted for creating new enterprises in rural areas.

Despite the aforementioned links between business and rural development, a few studies conducted in the direction of analysing the influences of small-scale business with human well-being and in the context of sustainable rural development. Besides, we decided to have a focus on low-tech solutions in this study, as it was discussed in **Chapter 1**. Therefore, the main object of this Chapter is first to analysis the characteristic of low tech innovations for creating new business in rural areas. The second object of this study is to analysis of interactions between business and human well-being to find out a

suitable answer to the question that "Can small-scale business support a quality of life in rural areas for locals?"

This Chapter analyses five enterprises in rural areas to identify the characteristic of low-tech solutions for creating new business. All presented cases have a unique idea, where low tech alternatives have a strong role in their business success. The first case is a business selling leaves in a mountainous area, the second a business selling rural life style, the third a business selling organic products from a micro organic farm, the fourth a business selling organic products, the fifth a business selling different products as a bio-based platform in a mountainous area (as a field study). All described cases have spent several years in their business model, whereas they have several achievements in maintaining environmental quality together with a positive influence on local development and local people. Therefore, analysing their business activities may be useful for application in other rural areas.

3.2 Methodology

To analysis the business cases, a conceptual framework was developed as it will described in Section 3.2.1. This was followed by a data collection step, in which several channels were used including desk study and a field study survey (see Section 0). Moreover, the main core of socio-economic assessment for life quality was established according to the OECD Guidelines on Measuring Subjective Well-being (2013).

3.2.1 Conceptual framework for analysing business model

In the present study, a conceptual framework was developed based on the Business Model Ontology (BMO) method to analysis business. The BMO model has been established to capture and identify business model innovation by considering several internal and external

attributes in its analytical structure (Osterwalder, Pigneur, Clark, & Smith, 2010). Besides, in different studies, this technique was applied as an effective assist analytical tool (Pousttchi, Schiessler, & Wiedemann, 2009; Tian & Martin, 2009; Wessa, 2009). The BMO consists of four main elements by which each business can be defined. These elements can be listed as product, customer interface, infrastructure management and financial aspects. Moreover, these four pillars are decomposed in to nine building blocks as shown in Table 3-1. In this analysis, all aforementioned business blocks were derived form a synthesis of the existing cases.

Table 3-1 Considered building blocks in the Business Model Ontology method (Osterwalder et al., 2010)

Element	Building Block of Business Model	Description
Product	Value Proposition	A Value Proposition is an overall view of a company's bundle of products and services that are of value to the customer.
Customer Interface	Target Customer	The Target Customer is a segment of customers a company wants to offer value to.
	Distribution Channel	A Distribution Channel is a means of getting in touch with the customer.
	Relationship	The Relationship describes the kind of link a company establishes between itself and the customer.
Infrastructure Management	Value Configuration	The Value Configuration describes the arrangement of activities and resources that are necessary to create value for the customer.
	Capability	A capability is the ability to execute a repeatable pattern of actions that is necessary in order to create value for the customer.
	Partnership	A Partnership is a voluntarily initiated cooperative agreement between two or more companies in order to create value for the customer.
Financial Aspects	Cost Structure	The Cost Structure is the representation in money of all the means employed in the business model.
	Revenue Model	The Revenue Model describes the way a company makes money through a variety of revenue flows.

3.2.2 Field study

A field study was conducted for analysing Kandelous Industrial-Group that is headquartered in Kandeous village as a remote village in the Mazandaran province of Iran. Several approaches were used in data collection step as it will described at the following of this Section.

3.2.3 Study area

Kandelous is placed in the Mazandaran province of Iran (see Figure 3-1), at the geographic coordination of 36°19'21" N and 51°33'54" E. The village is surrounded by the Alborz Mountains with a mean altitude of 1,650 metres from the sea level. Because of the geographical situation and long distance to cities, the village is considered as a remote and isolated area. Only one minor access road connects the village to the main access roads which is closed in winter time as a result of receiving heavy snow. Unfortunately, opening of this road until the middle of March, spring time in the region, depends on weather and available technical devices. Thus, some residences of the village migrate to city area in the winter time, whereas about 1 hour driving by car is required for reach to Nowshahr, the closest city and 42 Km far from the village.

Many residences of the village migrate to city area in the winter time, whereas about 1 hour driving by car is required for reaching to Nowshahr, the closest city and 42 Km far from the village. According to the last census record (conducted at the beginning of autumn in 2011), the village has about 915 people as permanent residences (according to the official definition as a person who stay more than 6 months in a year in a geographical place) (Statistical Centre of Iran; 2011). In spite of this official information data record and its definition about permanent residence, around 50 to 60 households were reported as dwellers of the village during the winter time (PRESSTV, 2016). Thus, around 100 adults above 30 years old can

be estimated in the village (calculated based on an average household size of 3.35, and a population ratio of 56 percent for adult above 30 years old) as the focus group size. However, during the data collection period, the researchers could not find many local people in the village with more than 5 years accommodation background.

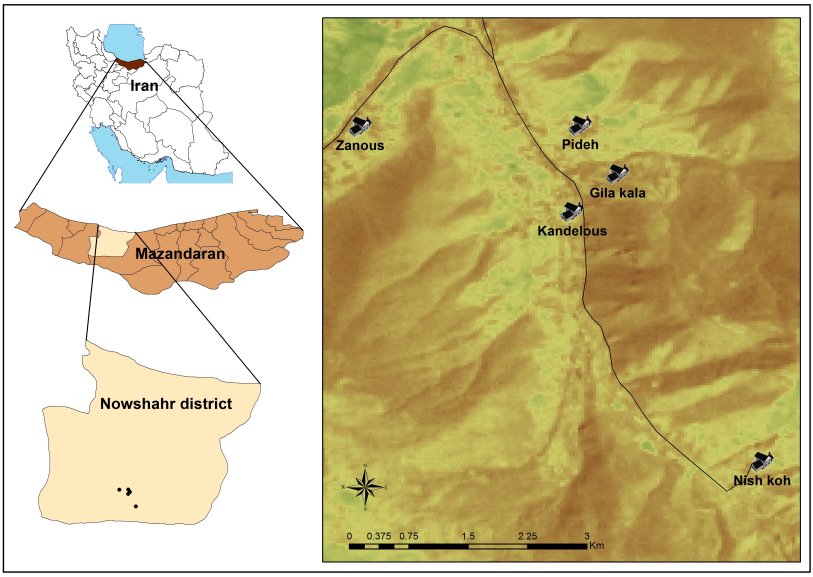

Figure 3-1 Location of Kandelous village in the Mazandaran province of Iran

3.2.4 Data collection

In this study, local people were assessed about the effectiveness on the enterprise in their local development in the village. In addition, several topics in social aspects were selected such as empowering women, increasing access to education, eradicating poverty. All subjective dimensions of life quality were judged by the permanent residences (i.e. a focus group) through in-depth interviews. A focus group of the locals, with more than 5 years accommodation background in the village and above 30 years old, was taken under investigation for getting feedback from the people who are well familiar with the region. To do this, several face to face in-depth interviews were performed with 22 permanent residences (11 men and 11 women) and the accommodation background was identified base on personal statement. All interviews were recorded with the consent of participants, transcribed verbatim and stored in a secure electronic folder. The responses were analysed using Microsoft Excel.

For face to face interviews, one of the researchers stayed in the village for three days in January 2015 to establish the connection with the local people. A local translator helped to speak with the local people, who have a special language (Mazani) in the region. However, with the well-educated people there was not too much difficulty because of personal familiarity of the investigators of this study with the Persian language. Moreover, because of a tourist facility in the village, a proportion of residences were familiar with English language.

3.3 Review on the selected business cases

A short overview on the selected business platforms is provided in the following in this Section. Two organic farming cases were selected due to important of farming in rural economy and *New Town* planning concept as it was discussed in **Chapter 1**.

3.3.1 The case of Irodori - a leaf business

The Irodori cooperation headquartered at Kamikatsu village, a mountainous region in southwest of Japan's main island of Honshu. This business venture was founded in 1986 after a typhoon disaster in the village. Earlier, the village people were mainly engaged with the cultivation of tangerines (a Japanese orange tree type) and lumber production. The typhoon destroyed the farms and village people were despaired about the future at that time. While, Mr. Tomoji Yokoishi, a member of agriculture union, proposed the idea of sealing leaves to luxury city restaurants. He was aware that decoration of Japanese dishes can be done by the available leaves resources in their region. Although four female farmers, mainly elderly people, believed that this idea could be a real business venture. Thus, the business venture was started with these local folks, who used to harvest same leaves for decoration of flowers. Since the tsumamono (garnish) leaves (see Figure 3-2) can only grow up under a certain condition, the local folks played an important role in the business platform to harvest leaves (Ministray of Environment of Japan, 2005). Besides, the cooperative farmers spent over 10 years on marking aspect for introducing a new item to the urban market. As a consequence of this effort, in the year 2013, the business was distinguished as the main Japanese supplier with about 80 percent share in the tsumamono market (Haga, 2015). In addition, the annual income of the enterprise was estimated around 3 million US dollars (about 300 million Yen), whereas approximately 200 farmers, mainly from locals, have employed in the company.

Figure 3-2 An example of "tsumamono (garnish)" used for traditional Japanese dishes (Irodori Company Ltd, 2018)

3.3.2 The case of Abass Barzeghar Touristic Village- a rural life style business

The Abass Barzeghar & Family Touristic Village is a family owned business which is located in the Bazm village, a remote village in the Fars province of Iran. This touristic village was indexed in several travel guide books such as Lonely Planet Iran (Richmond et al., 2017). Moreover, the enterprise got several entrepreneurship prizes and acknowledgement letters from different authorities including the Ministry of Labour and Social Affairs of Iran.

The story of this business begins with a stormy night, whereas two German cyclists got lost and coincidently they knocked Mr. Barzegar's door, for an accommodation. They were welcomed by Mr. Barzegar's family to have a place to sleep and a common Iranian dish "Dampokht-e Gowje", which means cooked rice with tomato. In spite the economic condition of Mr. Barzegar in that time, his family did not charge these two travellers. The day after, these travellers left the village with a good memory from Mr. Barzegar. As a consequence of this good memory, a month later, these two German travellers recommended Mr. Barzegar to their friends who had a plan to visit rustic places in Iran by their motor bikes. This group was interested to watch a nomadic tribe (Bavanat tribe) who can be found in some seasons close to the Bazm village. Thus, they asked from Mr.

Bazargar, who is familiar with the region, to be their tour guide as well. At the end of this visit, the group paid a good tip to Mr. Barzegar for his guide and hospitality. This tip was equal to around 200 days of his income in the farm. Therefore, Mr. Barzeghar came up with the idea of using rustic life style as a business platform.

Since 2001, Mr. Barzegar and his family members have started their business venture by branding their home place as a touristic complex. The enterprise was started with 3 rooms (these rooms are about 700 years old) and gradually the complex became a famous touristic hotspot, whereas the touristic complex were expanded to 37 rooms. In addition, the nearby farm was added to the complex to produce fresh organic food for the visitors. Nowadays, the enterprise's complex has about 120,000 square meters footprint size. While some parts of this open space are used for pitching tents for the guests from the beginning of April (depends on the weather). Recently, a photo gallery, an agriculture museum, an ethnology museum, a handicraft shop, and an herbal medicines store were added to the business platform. The costs of a night stay in this touristic complex is about 70 US dollars, which includes an organic breakfast and a vegetarian dinner. According to an interview of Mr. Barzegar with a German newspaper (Christiane Schlötzer, 2016), around 8,000 tourists are expected in the touristic complex per year. Thus, the annual income of the complex (without considering the income from renting tents) can be estimated around 500,000 US dollars, which is relatively high income in compare to the average rustic income in Iran. Since Mr. Barzegar and his family like to live in a rural life style, a part of this village is used as Mr. Barzegar's home.

Several touristic activities are conducted in the complex such as a welcoming section with local people who dressed in traditional nomadic clothes (see Figure 3-3), harvesting organic vegetables and fruits from the field inside the facility, milking cows, baking bread, and a traditional gathering event. In addition to aforementioned

business activities, the founders of company have a plan to start nomadic tour programs in the region.

Figure 3-3 An example of used nomadic cloths in the Abass Barzegar & Family Touristic Village

3.3.3 The case of Les Jardins de la Grelinette- a micro-farming business

Les Jardins de la Grelinette farm was established in 2004 as a micro organic farm by Mr. Jean-Martin Fortier and MS. Maude-Hélène Desroches. This farm has about 6,000 square meters footprint size (including a house, a green house, and a clod room) and it is located nearby the Bedford town in the Montérégie region of southern Quebec, Canada. An innovative market oriented approach was applied in this farm with a focus on optimizing the farming practice by using handmade tools and low-tech alternatives along with minimizing required time and initial start-up costs for farming.

The history of the company has a link the founders' academic background in environmental management field and desire to live in a peaceful place. Thus, they came up with the idea of having a small-

scale organic farm to support a quality of life for two people. In addition, a suitable work-life balance was an important goal for both founders to have an enough time to be with their family members. At the first step, both founders did several researches to learn how to approach to their goals, which was followed by an experimental try before the establishment of their owned farm. At the first step, they studied several books about organic farming including permaculture and intensification techniques. Besides, they visited several small-scale farms in French and Mexico to understand how to manage a mini-organic farm. Afterwards, they started an experimental phase in a land with about 2,000 meter size, which they got free of charge to examine the farming operation. This also should be highlighted that both founders had no farming skill before this experiment. After 2 years of running this farming and a visit from Cuba, they decided to start their owned-farm business through the Biodynamic French intensive farming approach, which was developed in University of California, Santa Cruz by integration of two different horticulture farming techniques including French intensive farming and biodynamic practice (Jeavons, 2001). After preparing a business proposal based on the obtained results from first experiment, they started to find a suitable place with a suitable price to minimize the investment costs. Finally, they purchased the current farm place by getting a mortgage form a bank. The old house inside the farm was renovated by the founders to a modern home. For doing this renovation, many waste materials were used to conserve the environment. In addition, several modifications were applied in the farm to prepare the land for installation of permanent raised bed system, which does not required any tractor for tillage. This modification started with a deep excavation operation to remove big rocks in the farm, which followed by installation of a drainage system. The start-up cost for the required devices and materials was reported around 39,000 US dollars (Fortier, 2014). The marketing flows were conducted through direct and indirect (as delivery to grocery shops) approaches. After all aforementioned start-up steps, the founders started with a direct selling strategy (as well as delivery to grocery

shops) to the surrounding community to grantee the income and design a production plan with considering the market demand. Thus, the founders visited several houses in the nearby area to get a year contact with these potential customers for selling fresh vegetable baskets to them. As a result of these efforts, gradually the enterprise became a successful community supported agriculture by having about 140 members for the year 2014. Each member has a one year contract and they can select the vegetable basket that includes an annual farming table event. This community oriented business part was allocated about 64 percent of the total annual income of the enterprise for the year 2014, which was reported about 150,000 US dollars. In addition to this business success, 4 jobs opportunities have been created in the farm (from March-December) to operate a three seasonal farming platform.

3.3.4 The case of Bec Hellouin farm - Organic farming business

The Bec Hellouin farm is placed near the Bec Hellouin village in the Normandy, France. In 2004, this enterprise was established as an organic business by Charles and Perrine Hervé-Gruyer. The farm has about 20 ha size (12 ha wood, 0.7 ha vegetable farm, and 650 m^2 green house) with an unlimited access to surface water, whereas a river passing across the farm. In addition to this water availability, a relatively high rainwater rate of 700−900 mm per year was reported for this area. In spite of a good accessibility to water, the soil quality in the farm was imposed some constrains at the beginning of business, whereas the alluvium-calcareous soil type was reported as the main available soil type (Morel, Guégan, & Léger, 2016). However, gradually this soil constrain overcame through using several approaches that had a focus on soil building (e.g. applying compost with no tilling practice). As a result, the productivity of the farm became an interesting topic for several research institutions including INRA-AgroParisTech (National Institute for Agricultural Research of French). In addition, the founders became the president of

permaculture farming in the Normandy region. Moreover, a school of permaculture was established in the farm as a part of business model.

The history of enterprise has a direct link to the former lifestyle of founders who used to life in a city area (as an international lawyer and sailor). Since both of founders were not satisfied with their life quality in that time, they decided to promote their life by moving to a rural area and start a business with a connection to the natural environment. Besides, the founders has several business goals such as reducing their ecological footprint along with a sustainable farming. Thus, the current farm was purchased in the year 2004 with a financial support from a bank. To obtain the required knowledge and skills for farming, a two year research period was conducted by the founders. After this research period, the permaculture concept and Biodynamic French intensive were selected as the farming systems (Jeavons, 2001; Mollison, 1988). In addition, an academic connection with the INRA-AgroParisTech (National Institute for Agricultural Research of French) was establish in that time. Gradually, as consequence of a good knowledge exchange, a high harvest results was claimed by the founders. While several research institutes became interested to evaluate the performance of the farm. Thus, a research project was conducted by INRA-Agro Paris Tech to evaluate the farming performance in the farm. To do this assessment, 1,000 square meters of cultivated area (without walkways and including 42% greenhouse and 48% agroforestry) was selected as a case study area and all the production performance was recorded in this part of farm for four years. According to the final report of this project, the annual income from the selected area, was recorded as an annual income of 65,000 US dollars for the year 2015 that associated with 1,600 hours of work in the garden (Guégan & Léger, 2015; Morel et al., 2016).

The enterprise has created 5 direct jobs in the farm including a chef who is responsible for cooking and processing products that sale directly at the farm. Moreover, two retailers are involved indirectly with the company to sale the agricultural products along with

marketing manager at the farm. Besides, several coordinators are working with different educational institutions for managing the internships and workshops in the permaculture school in the farm.

3.3.5 Case study of Kandelous Agro-Industrial Group- a conglomerate bio-based business

The Kandelous Agro-Industrial Group (KAIG) is a family-owned business, which was established around 1985 in a remote mountain area with a poor access to the outside of region. In spite of the local geographical constrains, the enterprise entered to the market by herbal business venture and later on, during 1985−1989, several parallel platforms were added to their business including a processing factory for natural cosmetics, art and cultural activities, and rural tourism. Therefore, this case is considered as a conglomerate business.

The founder of the company, Dr. Ali Ashgar Jahanghiri, an Iranian manager, a university teacher, is recognized among of the successful Iranian social entrepreneurs (Bahramitash, 2013; UN Development Programme, 2010). He was born in the Kandelous 1945, and then immigrated to urban areas to continue his educational careers (Yadeghari & Sanaeifard, 2011). His academic background, in polymer engineering, and a rapid success in a chemical company allowed for the accumulation of some capital. Due to his social responsibility, he began helping the local dwellers, who were very poor in that time, by delivering the basic livelihoods to them. Later on, he came to the idea of "teaching people how to fishing, instead of giving the fish". Therefore, Kandelous Agro-Industrial Group is established in 1985, for helping the local people of Kandelous with the slogan of "be healthy with nature". As a result, one of the important visions of the company is promoting the region to be a better place to live.

The seeding money of the company, which was about 100,000 US dollars is provided by the founder from his personal properties to buy

a suitable farm and to build a proper paved road access in the village. The construction of this road was one of the first activity of KAIG to access to the market. However, other business stakeholders and locals in the village can gain some benefits from this infrastructure development.

In herbal business platform, many natural products are being produced by the enterprise namely, shampoos, deodorizer, hair tonics, candies, spices, herbal medicine, natural essences, bio-cosmetics, essential oils and hygiene products. The complexity of the business platform possibly related to the personal characteristic of the founder, who disseminated a series of publications in the field of entrepreneurship and self-employment. Since 2005, Mr. Kasra Jahanghiri, the son of founder, a business graduate from University of California Los Angles, is responsible for managing the growth phase through Sybon Group of Companies, a parent company of KAIG. This part of the enterprise has more focus on productivity and efficiency in different sectors of the enterprise including trading, herbal products, distribution, rustic tourism, and R&D sector.

3.4 Analysis and discussion

The effects on the described enterprises on local people and development are discussed in the following of this Section.

3.4.1 Irodori's effects on local people and development

The influence of the enterprise on the society can be analysed among two main groups as 1) individuals who working with company, and 2) other people in the village. In the first group, effects of the cooperation should be highlighted for a female group because around 90 percent of the employees in the company are women (Haga, 2015). As it was discussed at the beginning of this Section, the founders of company were elderly female farmers. Although the company offers

some training workshops for the younger generations, still the age group of above 65 years old are the main part of this business. Therefore, for this specific age group, the income form the company counts as an extra income source beside their pension source. Thus, the business activities for the senior farmers may be viewed as an engagement in the society. Furthermore, a light physical activity is needed for harvesting leaves, which may affect the health status of workers. Interesting, the results of a conducted research in the village show that the Irodori's farmers have a better health status in compare to other farmers in the village (Inaba, 2013). This research was conducted by analysing the medical expends among the senior farmers. In addition, another conducted study on human well-being assessment shows that the Irodori's farmers are highly satisfied with their life (Yamaguchi, S., Kondo, H., Shibata, 2012). However, further study is needed to understand the linkage between this business activity and the reported life satisfaction level in this village.

On community side, creation of about 200 jobs opportunities in a remote village, with approximately 2,000 locals, can be notated as a successful business achievement. The enterprise was unlocked these job opportunities by an innovative approach to introduce a new item to the urban market. Interestingly, the cooperation used the existing resources in the village to create a business, whereas these resources were considered as valueless resources before the establishment of the company. In addition to the economic influences, the social impacts of the enterprise can be identified as a positive effect on solidarity, well-being of locals, and promoting the Kamikatsu to be a better place to live. The cooperation has a positive impact on learning computer and internet among the community which can help the locals to be connected to the outside regions. The ecological conservation should be considered by both locals and the enterprise because this business cannot run without the nature. However, further study is required to identify any environmental impacts.

3.4.2 Effects of the Abass Barzeghar Touristic Village on local people and development

The touristic complex has several impacts on community in terms of socio-economic-environmental domains. From social point of view, emotional impacts on local people can be expected by introducing the village as an international touristic destination. In addition, the company has an important role for conserving the traditional rustic culture, whereas an ethnology museum is a part of the business activity.

From economic point of view, the enterprise is a successful case by using the available rustic life style as a resource for business. The community has a supportive role in this business by welcoming the touristic groups along with sharing rustic life style. Since a visit from the Bazm village is a part of tour programmes, local shops were affected by this tourism wave. As a direct economic impact, several job opportunities have been created by the company in the touristic complex such as backers, carpet-weavers, handicraft makers, shepherds, and farmers. From environmental point of view, the surrounding farms was converted by the enterprise to an organic farm, which can be noted as a positive impact on local environment.

3.4.3 Effects of Les Jardins de la Grelinette on local people and development

The enterprise's business has affected local people and development in several ways. From economic aspect, the business model has several achievements as a small-scale agro-based platform in creating of job opportunities. This success has a link to the stat-up phase and a cultivation plan according to the market demand. The stability of income has a direct link to the direct annual contracts with final consumers, as a customer orientation marketing approach (Piller, F.T., Ihl, C., Vossen, 2010). This direct sale can be considered as a win-win

situation for both enterprise and supportive members, whereas the supportive members can have an access to fresh and organic vegetables with an affordable costs. Moreover, the founders published a handbook based on the obtained optimization experiments in the farm to share the technical knowledge that is associated with socio-environmental benefits along the economic influence.

From social aspect, the enterprise's business has more influence among the supportive members and employees. From company's perspective, the success of business has an emotional influence on founders to be more self-confident. From costumers' perspective, an annual party is conducted in the farm that can develop the social connection among the supportive members along with promoting local production. From environmental aspect, application of the permanent beds system can improve the soil fertility in a long-term period. Thus, as a consequence of this soil improvement, no chemical fertilizers are needed in this farming system. Besides, the founders developed handmade tools operational purposes that do not required any fossil fuel consumption. Therefore, from the environmental conservation aspect, a positive achievement is obtained as a result of this energy saving. Moreover, another positive step in natural resource consumption for this case can be highlighted, whereas several waste materials were used for renovation an old building in the farm.

3.4.4 Effects of Bec Hellouin farm on local people and development

The enterprise has affected the local people and develop in several ways. On economic side, the creation of 5 jobs has a positive impact on local economy. However, this impact is more highlighted among the working group in farm. The applied practice in the farm is highly productive, whereas around 42 US dollars per hour can be obtained from 1,000 square meters size. On social side, the success of enterprise has a positive emotional impact on founders to be more self-confident. Besides, educational activities in the business platform

have an influence among local gardeners to be more productive. This knowledge exchange has a positive effect on development of small-scale farmers. On environmental side, the cultivated vegetables and trees (about 90 types) in the farm is an ecological achievement to provide environmental goods and services for habitants of the farm and local people.

3.4.5 Effects of Kandelous Agro-Industrial Group on local people and development

The enterprise has affected the local development and people in several way, which is discussed at the following of this Section.

3.4.6 Economic effects on local people and development

The annual sale of the company in the recent years has been reported around 1.2 to 1.5 million US dollars (UN Development Programme, 2010). Successful economic growth of the company has generated more than 200 direct jobs, namely, 100 people in the farms, 34 people in the restaurant and guest house, 50 people in processing factory and shop, and 6 people in the headquarters. Each employee has a monthly salary between 350−500 US dollars, which is above the average rustic income, as the average net monthly salary for rural household has been reported about 350 US dollars in Iran (Statistical Center of Iran, 2014). Other indirect jobs such as product distributors and tour guides, mainly in urban areas, have also been generated by the enterprise's activities. Therefore, the cooperation can be viewed as a business platform in Kandelous, who serve urban-rural people through their activities.

The economic sustainability of the enterprise interacts with the community through several channels. First, the community provides the company with human resources, who are dependent on the income from the company. Rustic tourism contributes to a part of the

company's income and for maintaining this platform; a tourist-friendly atmosphere is required in the village which is provided by the local inhabitants. In fact, a part of the income of the local people also depends on the services and goods which are purchased by the visitors. Therefore, a mutual dependency exists between the enterprise and the community. Secondly, the shift in the economic base of the region from conventional agriculture and cattle farming to a more complex base (e.g. handicrafts and agro-eco-tourism), through the KAIG's business model, empowers the regional economy against unexpected economic shocks. Through the aforementioned interactions, and by capturing the added value, a more economic sustainable future in the region could be imagined.

The field study investigation indicates that the company has positive economic impacts on the community through several ways. Initially, KAIG introduces the village through their brand which has the same name as the village. KAIG encourages the costumers to visit the farms and buy the fresh product directly. In 2011 (March 2010−March 2011), the village had more than 50,000 visitors mainly from the domestic urban area as well as foreign countries (Islamic Republic News Agency, 2014). By bringing tourists and visitors to the region, there is a demand for services and facilities. These services namely, accommodation (see Figure 3-4), foods, and drinks, are provided partly by KAIG and partly by the community. Handicrafts made by the local community are proposed to the costumers through the company's shop in the tourist complex. In this case, the enterprise acts as a distributor for small businesses. However, some multifunctional shops have been established by locals to offer food and drinks and handicrafts in the village.

Figure 3-4 Kandelous Guest House

Kandelous Cultural Institute (KCI), as a part of the business platform, has published more than 20 books on different topics (e.g. herbal therapy, cultural topics, self-employments, and entrepreneurship) and music CDs for selling in the urban markets through the distributors in different provinces of Iran. Beside the cultural effects of KCI, more added value has captured in the village, by targeting another type of costumers in urban areas, who are interested in rural culture. The contribution of local authors and musicians to this institute has made some significant social impacts in the community which will discussed in the following social impacts assessment section.

Economic effectiveness of KAIG in the rural development was judged by the surveyed locals through the interviews. To the question “how strong do you evaluate the positive effect of KAIG in rural development? Please select the level as: very strong, strong, medium, weak, and very weak,” responders answered: very strong 36.4 percent, strong 50 percent, medium 13.6 percent, weak 0 percent, and very weak 0 percent. Interestingly, the majority of the surveyed people (with 84.4 percent responders) said that the Group has a strong to very strong positive effect on the rural development. To analysis the reason

for this economic achievement, the following additional questions were asked from the local people.

Question 1: In which way KAIG is the most effective for the development? Please select as: advancing the reputation of the village, revitalization of regional people, educating younger generation, establishing Kandelous Ethnology Museum and cultural festivals, stimulating economic activities, and others.

Results:

- Advancing the reputation of the village: 59.1 percent
- Revitalization of regional people: 18.2 percent
- Educating younger generation: 0 percent
- Establishing Kandelous museum and cultural festivals: 9.1 percent
- Stimulating economic activities: 9.1 percent
- Others: 4.5 percent

Question 2: Which of the following factors gives the village a prestigious reputation across the whole country? Please select as: KAIG's products, natural beauty, private ethnology museum, cultural festival, botanic garden, all the above mentioned factors, and other factors.

Results:

- KAIG's products: 9.1 percent
- Natural beauty: 4.5 percent
- Kandelous museum: 50.1 percent
- Cultural festivals: 0 percent
- Botanic garden:0 percent
- All above mentioned factors: 31.8 percent
- Other factors: 4.5 percent

The results of Questions 1 and 2 show that the company is more successful in the rural development by advancing the reputation of the village (with 59.1 percent of responders) rather than other factors such as revitalization of regional people, educating younger generation, establishing Kandelous museum, and stimulating the economic activities in the village. The reputation of the village has a strong link to Kandelous museum and the KAIG's products. About 50 percent of the surveyed locals thought that the museum gives the village a prestigious reputation rather than other factors such as KAIG's products, natural beauty, cultural festivals, and botanic garden. Moreover, external factors play a role in advancing the reputation of Kandelous, whereas few surveyed people (4.5 percent) pointed out this reason. Further investigation is required to identify these external factors.

3.4.7 Social effects on local people and development

Several social impacts can be detected in the village as the consequence of the enterprise's activities. For example, the KCI's activity has had a great effect on conservation of local heritage and culture through the publication of books, cultural festival, and establishment of a rustic museum (see Figure 3-5). In this regard, an elderly farmer in the village said in the interview that "*Now, I am proud on my traditional cloth, because many urban visitors come to the rustic museum in order to see how it looks like*". More than 8,300 gorgeous objects from the first millennium B.C. and Qajar dynasty (1794−1925) eras are kept in this museum including old music instruments, royal manuscripts, old books, locks, documents, antique appliances, and ancient agricultural tools. The majority of these pieces are from the personal collection of Dr. Jahanghiri. This museum is considered as the only privet ethnology museum's Iran, which running by a private company.

Obviously, social connections in the village have been positively affected by visitors, whereas having a friendly chat or a drink with them makes the local people feeling satisfied and enjoyed. It could be interesting for visitors as well to sit with the locals and feel more relaxed in a peaceful atmosphere and far from the hectic modern lifestyle in urban areas.

Figure 3-5 Kandelous Ethnology Museum

Since life has many social domains, some key aspects were selected for the rest of this study, namely empowering women, increasing access to education, eradicating poverty, and life quality. According to the Millennium Development Goals Report (UN Department of Economic and Social Affairs, 2015), the above mentioned domains are important goals in human development. All the selected subjective well-being topics were judged by the locals through in-depth interviews and the results are present in Box 3-1.

Box 3-1 Human well-being analysis

Question 3 - How much do you evaluate the positive effect of KAIG on empowering women? Please select as very strong, strong, medium, weak, and very weak.
Results:

- very strong: 22.7 percent
- strong: 45.45 percent
- medium: 31.85 percent
- weak: 0 percent
- very weak: 0 percent

Question 4 - How much do you evaluate the positive effect of KAIG on increasing access to education? Please select as very strong, strong, medium, weak, and very weak.
Results:

- very strong: 13.64 percent
- strong: 22.73 percent
- medium: 54.54 percent
- weak: 9.09 percent
- very weak: 0 percent

Question 5 - How much do you evaluate the positive effect of KAIG on eradicating poverty? Please select as very strong, strong, medium, weak, and very weak.
Results:

- very strong: 36.4 percent
- strong: 45.5 percent
- medium: 13.6 percent
- weak: 4.5 percent
- very weak:

Question 6 - How much do you evaluate the positive effect of KAIG on your life's quality? Please select as very strong, strong, medium, weak, and very weak.
Results:

- very strong: 13.6 percent
- strong: 50 percent
- medium: 31.8 percent
- weak: 4.6 percent
- very weak: 0 percent

The results of human well-being analysis (see Box 1) indicate that the company has positive impacts on empowering woman, increasing access to education, eradicating poverty, and life quality of the surveyed dwellers. It seems that the company is more successful in terms of eradicating poverty in comparison with increasing access to education, and empowering women. All the surveyed locals thought that the company has a medium to very strong positive influence on women's empowerment. This may link to the proportion of female to male workers in the company, considering about 60 percent of KAIG's employees being female (UN Development Programme, 2010). There are potential links between job and income with empowering women in a society (World Economic Forum, 2005). Perhaps this salary can help to fill the gender gap in a community.

Impacts of KAIG's activities on increasing access to education in the community need to be viewed from four key aspects. First, by constructing a primary school which is provided by the company, access to education has been facilitated for local residences directly. Second, the earned income by working with the company indirectly makes the education possible for local people. Third, some part of the income from the local restaurant also is allocated by the company to poor students in order to support their education. And finally, conducting some training for the local employees of the company has increased knowledge among locals.

In general, the majority of surveyed people (95.4 percent) mentioned that their life quality has been affected positively by the enterprise's activities (see Box 1-Qestion 6). However, a few among the studied people pointed out the weak choice. Perhaps, this results have a link to individual's life, whereas different people have different connections with a society and not an equal impact can be expected from a phenomena in a society.

3.4.7.1 Environmental effects on local people and development

Adaptation of the conventional agriculture to bio-based agriculture needs a significant modification in farms, in order to avoid the application of chemical pesticides. Therefore, KAIG's agricultural practice is more environmental friendly in comparison with the past records of agriculture in the village. Some environmental benefits have occurred as a result of the herbal medicine cultivation in the region. First, the enterprise is conserving the biodiversity by cultivating rare herbal species and bringing new species, including more than 250 plants type (e.g. *Rosemarinus Officinalis*, *Aloe Vera*, *Echinacea*, and *Melissa*), into the company's farms. Second, as an indirect benefit, replacing synthetic remedies by natural one will reduce the volumetric load of pharmaceuticals in wastewater system. Thus, as a consequence, some water protection goals can be achieved. Third, humus of soil, which plays important roles for any ecological system (Weil & Brady, 2016), seems to be promoted in the unplanted areas that have been cultivated by the Group. These areas have been estimated to be around 40 ha.

The major income of the company comes from herbal farms. As a result, protecting these farms for the company, and the community, has become an important issue. Since maintaining the environmental quality is an important issue among locals, the rural consul of Kandelous has approved a regulation to ban selling land to the non-residents. This also should be noted that land use change from agriculture to residential building is acknowledged as one of the ecological challenges in the Mazandaran province. In addition, about 60,000 tourists and visitors per year travel to the village which has resulted in development of a solid waste management service that keeps the surrounding areas clean. A downside of the rural tourism is additional traffic in the region. Further environment assessments may be required in order to evaluate the progress on environmental protection issues in the village. Although, several achievements have been detected as mentioned above.

3.5 Summery

The cases described in this Chapter illustrates some similarity in relation to rural development.

1) Rural economy within a small-scale business size can be profitable: Within all cases, a suitable profit for supporting quality of life in terms of economic materials can be observed. However, each business case has a different approach to reach to this goal. The profitability of all mentioned businesses have a link to management skills rather than application of high tech solutions or size of business. In addition, the important key success in all mentioned cases has a direct link to technical knowledge, whereas in two cases (Bec Hellouin and Les Jardins de la Grelinette) both enterprises spent several years to learn how to become highly productive in a small-scale farm.

2) Direct marketing strategy and capturing more added value: In all cases, the enterprises have a direct marketing strategy to find final consumers. This is more highlighted for the Les Jardins de la Grelinette case, where the main income of the company is depended on supportive agricultural members as final costumers rather than grocery shops. In addition, all enterprises have different ways to capture more added values in their company. For example, in the case of KAIG, the enterprise has developed different sectors in the business platform such as accommodation and museum.

3) Unlocking of rural economy with a focus on low-tech alternatives: The success of all mentioned cases have a direct connection with application of low-tech alternatives. For example, in two cases (Bec Hellouin and Les Jardins de la Grelinette) for farming operation, several handmade tools were developed with a focus on using local labour instead of motorization. However, labour working load was optimized in both cases to maintain a suitable work-life balance. For example, in the Bec Hellouin case about 1,000 square meters land

can handle by a farmer with 8 hours of work per day. In Irodori case, no high tech installation was used to introduce a new commercial item to the market. This is very similar to the Abass Barzegar and Family Touristic Village case, whereas the existing rustic life style became as a means of business without using any high technology application.

4) Influence with social development: In all mentioned cases, a strong influence between social development and business was detected. For example, In case of Les Jardins de la Grelinette, social connection in the village and among the supportive agricultural members was developed by an annual farming event. The social influences of two cases (KAIG and Irodori) are more highlighted among women group, whereas the majority of employees are female. The field study survey indicates that the KAIG enterprise has had a positive impact on social development in terms of empowering women, increasing access to education, eradicating poverty, and promoting life quality of dwellers. Based on the evaluation of the surveyed locals, the KAIG has a medium to very strong positive influence on women's empowerment.

Chapter 4 Human well-being in rural area and sustainable development-Case study of Kandelous village

4.1 Introduction

Inspire to find out an answer to the question "*Can a rural area be a better place to live*?", a conceptual framework is developed for assessing human well-being in the Kandelous village of the Mazandaran province of Iran. The influences of Kandelous Agro-Industrial Group in the village were discussed in **Chapter 3**. While, in this Chapter we will mainly explore more about the quality of life of the local people through selected indicators in housing, earning and job, work-life balance, education, environmental quality, health, civic engagement and governance, personal security, social connections, happiness, and life satisfaction topics. All aforementioned topics are selected to capture a comprehensive perspective in different domains of life. In this investigation all subjective topics were judged by a focus group of locals and according to their feelings about their well-being.

4.2 Review on the selected topics in conceptual framework

As it was discussed in **Chapter 2**, life has many aspects. Thus, we decided to limit the scope of this study with the following topics and indicators, whereas a short review on the role of the selected topics in human well-being assessment is provided as below.

4.2.1 Housing

The mental image of a house can be reflected as a safe and secure place to live while, it is acknowledged as one of the important material

of life (along with the others materials such as food, water, air, etc.) (Böhnke & Kohler, 2010; Maslow, 1943). Despite the fact that housing cost contributes to a large part of household expenditures in the study area (Statistical Center of Iran, 2014), housing status affects other socio-economic-environmental domains of life and other way around (Domański et al., 2006; Glaeser & Sacerdote, 2000; Mithraratne, Vale, & Vale, 2007; Ramesh, Prakash, & Shukla, 2010). Therefore, housing conditions should be viewed as a part of living standards in any integrated well-being assessment.

Housing conditions can be analysed in terms of the physical characteristics of buildings (e.g. living space, availability of electricity, water supply, indoor flushing toilets, bathroom requirements, cooking facilities, the quality of materials and construction, energy saving, type of structure, application of environmental friendly materials in construction, and etc.), socio-ecological characteristics of the areas where the buildings are located (e.g. access to public transportation, exposure to noise, indoor pollution, etc.), economic factors (e.g. ownership, costs of housing, etc.), social factors (e.g. health status, personal privacy, etc.) (Domański et al., 2006; Glaeser & Sacerdote, 2000). We adapted our measures based on two important perspectives of living space (see Section 4.2.1.1) and general satisfaction with housing condition. These aspects of housing are selected due to two reasons. First, in our case study area all houses equipped with basic services including flushing toilet, electricity, sanitation, and water supply. Thus, we decided to exclude the accessibility to basic services in this survey. Second, overall satisfaction with housing directly can be representative of existing gap between respondent's needs and their current housing condition (Galster, 1987).

4.2.1.1 Living space

A sufficient space can be considered as one of the requirements to make a house as a pleasant place and to fulfil the need for privacy. While insufficient living space has been mentioned as a major housing problem in several studies (Myers, Baer, & Choi, 1996). Since a crowded accommodation (i.e. less living place per person) negatively influences the personal privacy (as one of the personal expectation for housing), children's wellbeing (Solari & Mare, 2012), and self-development (Domański et al., 2006).

The amount of enough living space depends on several factors namely our needs (e.g. sleeping, washing and dressing, cooking and eating, gathering, storage, care of infants, etc.), social (e.g. size of family, culture, etc.), technical (e.g. required space for basic services and infrastructures, etc.) and environmental (e.g. in a cold climate the major household activities take place in covered areas therefore a higher internal space is required) factors. Thus, living space is studied here as one of indirect indicators of well-being in terms of material of life. For measuring living space, three main indicators are selected as overall home size, average floor space per person, and household size, whereas in other studies the same indicators has been used (Domański et al., 2006).

4.2.2 Earning and job

Life is beyond the economic aspect. However, the importance of economic domain in our well-being should be highlighted, where materials and resources can be purchased from the market by means of economic transaction to satisfy our basic needs. In spite of this important role, a higher earning rate will not certainly result in a better life status (Clark, Frijters, & Shields, 2008), whereas life can be defined as a complex of various ingredients. Moreover, several aspects of our life such as social (e.g. access to health care services,

access to education, etc.), and environmental dimensions can affect by financial wealth, and vice versa (Gallagher & Thacker, 2008). Thus, earning is evaluated in this study as a part of well-being assessment.

In rural economy context, it should be noted that economic transactions are conducted in both direct (i.e. under a barter system by exchange the goods and services without the use of money) and indirect (i.e. under a monetary system by use of money a unit of account) pathways. However, in this case study we assumed that locals are familiar with indirect economic transaction (by means of money) because of two main reasons. First, as a common demand in each house, energy (i.e. in forms of oil, petrol, gas, and electricity) needs to supply from urban markets. Second, about 50,000 visitors (i.e. domestic and international tourists) per year are expected in the village (Islamic Republic News Agency, 2014). Hence, in the present study all economic measures were analysed according to the money transaction pathway and national currency unit (i.e. Riyal). For doing this, average monthly gross income, direct income tax, household expenditures costs, and self-reported job satisfaction indicators are used.

4.2.3 Work-life balance

A balance between work and non-work activities (i.e. time spent in leisure and personal care), is defined as work-life balance (Aguiar & Hurst, 2007). Without this equilibrium in our life, several consequences can be expected. On one hand, less income can be predictable with a low working time. Thus, according this assumption, there is a direct relationship between working time and income. On another hand, a heavy working time negatively can affect other dimensions of life such as health, personal behaviour (e.g. anxious, frustrated, and impatient), happiness, social connections, family relationship, and overall quality of life (Spurgeon, Harrington, &

Cooper, 1997). Therefore, work-life balance is a crucial issue in life, which it needs to be integrated in well-being assessment.

In this study, the self-reported work-life satisfaction index is selected to analysis this aspect of human well-being. In addition, working and non-working activities are studied to have a better understanding about working and non-working activities. Thus, time spent in working activities, personal care and leisure, domestic chores are considered as complementary measures along with the self-reported work-life satisfaction index.

4.2.4 Education

Education can be viewed as a process for satisfying our basic needs to know, learn, explore, and discover. While it is essential to have a better understanding for our surrounding environment (i.e. manmade and natural environment) and promoting our lives (Kjeldsen & Bonvin, 2015). The outcomes of educational process have a strong influence on our life in terms of economic (e.g. access to job opportunities, earnings, etc.) (Sianesi & Reenen, 2003; Strauss & Boarini, 2011), social (e.g. social behaviour, health status) (Miyamoto and Chevalier, 2010; La Fortune and Looper, 2009), civic engagement (Dee, 2010; Borgonovi and Miyamoto, 2010), crime rate (Jonck, Goujon, Testa, & Kandala, 2015), helping others, environmental (Clarke, 1993) aspects, and vice versa. Therefore, education is analysed here as a key part of well-being assessment.

Several dimensions in education have been measured to evaluate the educational status including literacy rate, schooling years, educational level, educational attainment, education expectancy, lifelong learning, educational costs and along with others. We adapted our measure based on adult literacy rate parameter due to number of reasons. First, ability to read and write are key parts of learning a language, whereas it is recognized as an important channel for communication within a society (see Section 4.4.9). Second, further stages of educational

development such as secondary level cannot be achieved without the ability to read and write. Third, according to the Millennium Development Goals Report (2015), combating illiteracy is one of the universal goals across nations.

4.2.5 Environmental quality

Planet earth is the only planet in our solar galaxy, which human beings are able to live on that and our biological life without environmental goods (i.e. water, air, and food, and etc.) means death. Besides, a poor environmental quality is correlated to more than 80 percent of our major diseases (WHO, 2006). Moreover, it is a proven relationship between pollution (e.g. nitrogen dioxide concentration) and our personal behaviour such as happiness (Welsch, 2002, 2006).

Without going to into details, let us take a look at some of the negative side effects of environmental quality on health status. If you become sick, as a consequence of a poor environmental condition, perhaps you need to go to a physician, take some medicines, or a serious treatment in a hospital. All the aforementioned activities will affect your life in terms of economic and social aspects in several ways. First, you have to allocate some time for visiting a doctor or staying in a hospital. Second, you need to postpone some of your job tasks, which might affect others. Third, some financial resources need to be provided, directly (i.e. by yourself) or indirectly (i.e. by means of insurance coverage or social services), for take a medical treatment or visit a physician. Fourth, when you stay in a hospital literally it means that you are not happy or something is wrong with your body, which might be resulted in some bad feeling such as being isolated from the rest of the world. All in all, a negative correlation between local environmental problems and life satisfaction exists (Ferrer-i-Carbonell & Gowdy, 2007). Therefore, environment quality is another key element in human well-being.

Several objective and subjective indicators have been applied for measuring environmental quality namely air quality indexes, water quality indexes, environmental burden of disease, access to green spaces, and satisfaction with the quality of local environment. We adapted the satisfaction with the local environment as a subjective measure for the rest of this study because of two reasons. First, subjective data can provide some important information about our environmental condition while it cannot capture by objective measures. Second, by taking into account lack of available data, it would be not many options left. Usually, satisfaction with air and water are considered in subjective environmental quality assessments. However, soil quality needs to be included in environmental assessment by considering agriculture, livestock, and gardening, as the main economic activities of rural business (see Section 3.2). This is because of several interconnections between soil-water-food nexus as it is explained in the following. First, globally, about 88 percent of rainfall (as a freshwater source) held in the soil and retain again into atmosphere (UN Environment Programme, 2007). Second, soil quality directly regulates local temperature by influence on evapotranspiration and this can affect agriculture and farming. Third, the capacity of top soil for trapping rainfall affects water bodies (i.e. surface and underground water), and availability of water for farther usages, which has an indirect impact on income of farmers (as a main economic activities for rural areas). Forth, another related industries such as dairy products will also receive some negative impact as a consequence of a poor soil condition. Therefore, soil quality is also included in this assessment.

4.2.6 Health Status

Life without a healthy condition, even with a suitable economic condition cannot be a well life. Several factors have influence on our health status including our environmental (i.e. air, water, soil and food quality), economic, social, and lifestyle characters (e.g. eating and

drinking behaviours, doing sport, smoking, etc.). A poor health condition has a negative impact on other aspects of life such as economic (e.g. income and job) and social dimensions, and other way around. Thus, health status should be a part of well-being assessment.

Many indicators have been used for measuring heath status such as life expediency at birth, infant mortality rate, morbidity rate, overweigh and obesity rate, and self-reported heath status (Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997; OECD, 2011; WHO, 2015). The self-reported health status is selected for this study due to two reasons. First, it is very idealistic to review all of health indicators and for doing that a lots of research work is required. Second, each indicator represent a specific spectrum of health status, whereas the self-reported health status indicator can be used as a single measure for summarising our overall heath statue (OECD, 2011).

4.2.7 Personal security

Safety and security are parts of basic human needs (Maslow, 1943), and by reviewing the history of early human settlements (Morris, 2013), personal security can be considered as a powerful sense for gathering people in a geographical place (i.e. sedentism). As Bauman says, "*We cannot be a mankind without security and freedom*" (Bauman, 2001).

Different threats to personal security can be detected as political conflicts (e.g. war), natural disasters (i.e. earthquake, flood, hurricane, volcanic eruptions, etc.), man-made environmental issues (e.g. deforestation, desertification, acid rains), economic collapses (e.g. high unemployment, hyperinflation, etc.), industrial collapses (e.g. Chernobyl accident), crime, terrorism, internet security (i.e. cyber attracts, virus, worms, etc.), and along with others. The feeling secure for walking after dark is selected for measuring personal security in

the village because of three reasons. First, it is very idealistic to review all of potential threats (i.e. a lot of research works need to be done). Second, in the case study area, as a remote rural area, some of the above mentioned threats are not common in that region. Third, from psychological point of view, feeling security is as important as being safe (Adams and Serpe, 2000).

4.2.8 Civic engagement and governance

Civic engagement can play an important role for shaping our society in terms of socio-economic-environmental dimensions. This role is highlighted, where promoting the political aspect is recognized as a necessity to well-being (Sen, 1999; Sener, 2012). Thus, we should manage our lives by ourselves and it is better to include every members of a society in a decision making process in all of the governmental institutions to have a better life, whereas people feel more valued (Sen, 1999), connected, and satisfied for this participation. Thereby, civic engagement is studied here as a part of human well-being assessment.

Measuring the political participation in a community is a challenging task because people can contribute in governmental sectors through several forms of political activities such as voting, campaign activity, joining a political party, protest activity, contributing money, and along with other pathways.

A suitable civic engagement level cannot be established without trust between people and a government. Therefore, trust can be viewed as one of the fundaments for democracy (Morrone, Tontoranelli, & Ranuzzi, 2009) and economic growth (Glaeser, La Porta, Lopez-de-Silanes, & Shleifer, 2004; Knack & Zak, 2003). This indicator can be investigated in several political levels such as international, national, regional, and local levels. The trust in a local level is selected for this study, whereas a local council is the only representative of central governmental departments. The council members are responsible for

developmental progress in the village and they are partly supported by the central government in terms of finance. Each council member is elected by the locals in every four years (Iranian Legislative Parliament, 1996).

4.2.9 Social connections

As human beings, we are social creatures in our surrounding environment, whereas *Maslow* says "*Social life is a part of our needs*". Usually, most of people feel satisfied and enjoyed by spending time with other people such as family members and friends (Kahneman & Krueger, 2006; Kimweli & Stilwell, 2002). The quality and regularity of social connections can affect many aspects of life namely intellectual capital (i.e. trust, mutual understanding, emotions, and shared values) (Halpern, 2005; Kearns, Whitley, Tannahill, & Ellaway, 2015), health status (Halpern, 2005; Kahneman & Krueger, 2006; Ichiro Kawachi, Subramanian, & Kim, 2008; Putnam, 2000), civic engagement (Halpern, 2005), education (Topa, 2001, Calvó-Armengol and Jackson, 2004; Moretti, 2004; Bayer, Ross and Topa, 2008; Zenou, 2009), personal security, exchange of information and knowledge (Nonaka & Takeuchi, 1995), access to economic opportunities (Gush, K., Scott, J., Laurie, 2015), and vice versa. The importance of social connections should be highlighted, whereas a poor interpersonal connection can result in several impacts on our social capital including alienation (i.e. a high degree of distance or isolation between individuals) and family breakup (Lee & Robbins, 1995). Thus, social connections evaluation should be a part of well-being assessment.

Measuring social connections on an interpersonal scale is a complicated topic because we can communicate with each other in different places (i.e. private and public places such as home, work, etc.) via several direct (i.e. face to face) and indirect ways (e.g. telegraph, telephone, radio, motion pictures, television, and most

recently the internet). Among all of these communication channels, the internet phenomena is very common in our life, whereas around 3.2 billion people (i.e. about 43 percent of our world) in 2015 used this technology for different purposes including economic (e.g. online buying or selling products), and social (E-mail, chat, news, learning, etc.) aims (International Telecommunication Union, 2015; Ruzgar, 2005). However, the internet usage can affect our social connections intensively in a both positive and negative ways. On one hand, the internet usage, as a means of communication, can be viewed as a catalyst for developing and maintaining interpersonal relationships (Hampton & Wellman, 2001; McKenna & Bargh, 2000; Stafford, Kline, & Dimmick, 1999). On the other hand, the internet can be considered as a monster to our traditional face to face connections, whereas Nie & Erbring (2002) reported several negative impacts of the internet usage on our mental health namely, increases in depression, loneliness, and neglect of existing close relationships (Nie & Erbring, 2002). All in all, it seems that the internet communication way is not a strong way for social connections, at least for some of us, and the face to face communication channel is needed as well. We adapted our methodology based on this thought.

Various indicators such as rates in membership of social entities (e.g. sport clubs, religious centres, professional organizations, etc.) and voluntary organisations have been more frequently used in literature as indirect parameters for measuring social connections in informal dimensions of life, whereas life can be categorized as formal and informal aspects. However, some scholars have emphasized on measuring social connections in informal aspects for capturing real behaviours of human beings (Stiglitz, Sen, & Fitoussi, 2009). Thus, three parameters are selected in this assessment for measuring informal aspects of social connections including interpersonal trust (as a necessity for social connections), having someone to count on in times of need (as a representative of close social connections), and time spent volunteering (as a representative of supportive social connections).

4.2.10 Happiness

Happiness is referred as one of the ingredients of life (King & Napa, 1998) and most of us want to be happy. Being happy has a positive effect on other well-being dimensions namely life satisfaction (Bastian, Kuppens, De Roover, & Diener, 2014), income (Diener & Seligman, 2002; Ostir, Berges, Markides, & Ottenbacher, 2006), unemployment (Di Tella, MacCulloch, & Oswald, 2001), health, marriage, and lifespan (Lawrence, Rogers, & Wadsworth, 2015). A group of scholars has established accumulative indexes in order to calculate our national happiness, which literally means the simulated indexes by considering socio-economic-environmental factors (Helliwell, Layard, & Sachs, 2017). However, these simulated indicators cannot be a representative for individual well-being. Thus, the self-reported happiness index is selected for this survey.

4.2.11 Life satisfaction

Life satisfaction is an important part of societal well-being because it explains how much we are positively satisfied with our overall life condition as a whole subject (Veenhoven & Saris, 1996). The overall well-being evaluation is useful along with the economic, social, and environmental measures because each subjective measure only reflects a specific dimension of life and it cannot be a representative for our whole life satisfaction, and other way around (Kapteyn, Smith, & Soest, 2009; OECD, 2011; UK Office for National Statistics, 2015). Life satisfaction can be measured by self-reported life satisfaction index (OECD, 2011), which is selected for the rest of this assessment.

4.3 Methodology

The methodology was based on a conceptual framework (see Section 4.3.1) and a data collection step (see Section 4.3.2) that are explained in the following of this Section.

4.3.1 Conceptual framework

A thematic analysis was developed according to OECD Guidelines on Measuring Subjective Well-being (2013) and First European Quality of Life Survey (2006). Among many important aspects of life, we have selected 11 topics for this study, which is shown in Table 4-1. All subjective dimensions were judged by the permanent residences (i.e. focus group) through deep-interviews. We adapted our study based on a focus group of the locals, with more than 5 years accommodation background in the village, to get feedback from the people who are well familiar with a rustic lifestyle.

Table 4-1 Selected topics for well-being assessment

Main topics	Indicators
Housing	Home size Average floor space per person Self- reported satisfaction with housing conditions
Earning and job	Employment ratio Economic structure Gross monthly income Average housing expenditures costs Self- reported satisfaction with job
Work-Life balance	Average daily time spent in working Average daily time spent in personal care and leisure Average daily time spent in domestic chores Self-reported satisfaction with work-life balance
Education	Adult literacy rate
Environmental quality	Self-reported satisfaction with the quality of air Self-reported satisfaction with the quality of water Self-reported satisfaction with the quality of soil
Health	Self-reported heath status
Civic engagement and governance	Self-reported contribution with local authorities
Personal security	Self-reported personal security feeling
Social connections	Trust in others Close social relationship status Time spent volunteering
Happiness	Self-reported happiness status
Life satisfaction	Self-reported life satisfaction

4.3.2 Data collection

Data collection was carried out through a multi-channel approach including interviews and census records (Statistical Center of Iran, 2011). The earning and job measures were assessed based on local currency Riyal (almost 30,000 Riyal is equivalent to one US dollar). For evaluating the housing conditions and employment, 4 more villages (see Figure 3-1) close to the Kandelous village were also included to have a better understanding from the region as well.

Several face to face in-depth interviews were performed in January 2015 with 22 permanent residences (11 men, 11 women, and children are not included), who stayed more than 5 years in the village. The accommodation background was identified based on personal statement.

Each interview took approximately 35−40 minutes and the participants were encouraged to speak longer. All interviews were recorded with the consent of participants, transcribed verbatim and stored in a secure electronic folder. The responses were analysed using Microsoft Excel.

For face to face interviews, one of the researchers stayed in the village for three days in January 2015 to establish the connection with the local people. A local translator helped to speak with the local people, who have a special language (i.e. Mazani) in the region. However, with the well-educated people there was not too much difficulty because of personal familiarity of the investigators with the Persian language. Moreover, because of a tourist facility in the village, a proportion of residences were familiar with English language. Due to seasonal migration of the locals to city areas, we could not find many local people who stayed more than 5 years in the village during that time.

4.4 Result and discussion

The results of human well-being assessment for the selected indicators in the Kandelous village are present in the following of this Section.

4.4.1 Living space assessment

The average home size and average floor per person indicators were calculated based on the extracted data from the last updated census records and the results are presents in Table 4-2. Among the surveyed villages, the majority of houses in Kandelous (i.e. 204 out of 273), Zanous (i.e. 62 out of 79), Gila Kala (i.e. 80 out of 111), Nish Koh (i.e. 104 out of 136), and Pideh (i.e. 42 out of 56) are within a range of 51−100 m^2. The average size of home was not reported at the scale of villages in the census records and it is required for calculating the average floor space per person (as a representative for living space). To estimate this, we adapted our methodology based on the majority of home size ranges (i.e. 51−75 m^2 and 76−100 m^2) because of three reasons. First, including the upper official mentioned range (i.e. from 101 to 150 m^2), which has a broader spectrum (i.e. from 101 to 150 m^2) in comparison to others (e.g. 51−75 m^2), can increase inaccuracy in our estimate. Second, in the lower official homes range (i.e. less than 50 m^2) it is not clear how small are they. Based on this assumption, the estimated average home size in each villages are present in Table 4-2, whereas Kandelous, Nish Koh, and Pide have a close ratio to 20 m^2 per person. This ratio is slightly below the Mazandaran province, whereas a rate of 26.69 m^2 per person can be estimated from census records in 2011 (i.e. calculated based on average rustic home size of 88.1 m^2 and a household size ratio of 3.3 for Nowshahr district in the Mazandaran province). The available floor space per person in Kandelous is also very smaller in comparison with Germany (as an example from OECD countries), where a rate of 48.2 m^2 per person reported (i.e. calculated based on First European Quality of Life Survey, 2006). However, the smaller living place in

the village might has a link to assess to the required resources (i.e. materials, labours, etc.) for construction, harsh winter time, costs of energy for heating, and other involved socio-economic factors as well.

Table 4-2 Living space analysis in the selected villages

		Kandelous	Zanous	Gila Kala	Nish Koh	Pideh
Home size range (Number of houses)	below 50 m^2	59	1	6	32	11
	51−75 m^2	168	11	63	100	34
	76−100 m^2	36	51	17	4	8
	101−150 m^2	10	16	25	-	3
Average house size (m^2)		67.41*	83.56*	68.31*	63.96*	67.76*
Total population		915	214	162	428	182
Total houses		273	79	111	136	56
Average floor space per person*		20.12	30.95	46.78	20.30	20.85

* Estimated value based on number of houses in 50−75 m^2 and 76−100 m^2 ranges.

4.4.2 Satisfaction with housing assessment

This indicator is based on the question "*How much you are satisfied-dissatisfied with your current housing*?" and responds are reported in the scale of very strong to very weak. We asked local people about their housing satisfaction and the results are presented as follow.

Question - How much you are satisfied with your current housing? Please select the level as very strong, strong, medium, weak, very weak, and I am dissatisfied with my home place.

Results:

- Very strong: 22.7 percent
- Strong: 50 percent
- Medium: 27.3 percent
- Weak: 0 percent
- Very weak: 0 percent
- I am dissatisfied with my home place: 0 percent

All of the surveyed people mentioned that they are satisfied from their housing at a scale of medium to very strong. Interestingly, nobody among the surveyed people is dissatisfied from housing, while across OECD countries about 15 percent of people are not satisfied from their housing condition (OECD, 2013). This might have a correlation with expectations of people from their housing and several involved socio-economic-environmental parameters.

4.4.3 Earning and job assessment

4.4.3.1 Employment

Employment in the study area were analysed based on employment ratio in different economic sectors and employment backgrounds and the results are present in Table 4-3. The obtained results show that agriculture is one of the main economic activities of the region, in which the Kandelous village has the higher employment ratio in industrial sector (48.26 percent) among the surveyed villages. This might have a link to the existence of a touristic centre, a restaurant, an ethnology museum, and a tourist complex in the Kandelous village. Besides, as it was discussed in Section 3.3.5, an industrial agro-based enterprise (KAIG) is located in the village, which has about 200 employees. The employment ratio backgrounds analysis in all villages illustrate same trend of occupation, whereas in all villages employment ratio is above 81 percent. This ratio is highlighted, where across OECD countries on average about 65 percent of employment rate is reported (OECD, 2013).

Table 4-3 Employment analysis in the region

	Employment by sector* (percentage)			Employment rate[1] (percentage)
	Agriculture	Industry	Service	
Kandelous	15.46	48.26	36.28	87.40
Zanous	73.97	16.44	9.59	94.05
Gila Kala	59.68	17.74	22.58	87.77
Nish Koh	44.68	47.52	7.80	90.24
Pideh	27.45	50.98	21.57	81.25

* Extracted from national census records in 2011

[1] Calculated based on the percentage of the employed 10-64 aged over the population of the same age.

As it was discussed at the beginning of this Chapter, energy is one the common demands among locals, whereas the village is surrounded by mountains and the outside temperatures drop down to -15 degrees of Celsius during the winter time (extracted from Iran Metrological Organization for Kajoor Synoptic station). Hence, energy saving is an important issue in the village, where the average size of houses are relatively smaller in comparison with other provinces in Iran (Statistical Center of Iran, 2011). The harsh winter condition affects behaviour of dwellers and architectural aspects as well, whereas still a public bathhouse (i.e. Hammām in local language) is under operation in the village. Despite the fact that traditional public bathhouse is one the old element of Persian architecture (Kheirabadi, 2000), most of bathhouses in Iran have been changed to museums. Thus, this public bathhouse became a touristic destination for visitors. Besides, this building is a social gathering place in the village, where local go to bath, massage, and shave. In addition to this, According to one of the locals, a significant cost saving for hot water in each house can be achieved. However, this statement need to study further.

4.4.3.2 Earning and job satisfaction

We asked from locals to evaluate their gross monthly income, housing expenditures costs, and job satisfaction and the results are presents in

Box 4-1. The obtained results for gross monthly analysis (see Box 4-1, Question-1) show that around 95.5 percent of surveyed people have an income source, while 4.5 percent said that they do not have personal income source (e.g. such as housewife). In addition, the majority of survived people (59 percent) have a gross monthly income range more than 10,000,000 Riyal, this monthly income is slightly above the reported average monthly net rural household income (10,083,333 Riyal or annually 121,000,000 Riyal) in the Mazandaran province of Iran (Statistical Center of Iran, 2014). Moreover, the gross monthly income above than 11,500,000 Riyal is subjected to direct income tax (Iranian National Tax Administration, 2015), thus the majority of people are contributing with their development progress by paying direct income taxes. Besides, , about 1.5-10 percent is also defined as VAT in the study area (Iranian National Tax Administration, 2008).

The results of house expenditures analysis (see Box 4-1, Question-2) show that household expenditures costs are less than 30 percent of income among the 95.5 percent of survived people. While only a few people (4.5 percent) said that they spend between 30−40 percent of their income for household expenditures costs. In addition, the majority of surveyed people (72.8 percent) mentioned that their household expenditures costs are between 10−30 percent of their income level.

The results of self-reported job satisfaction analysis (see Box 4-1, Question 3) illustrate that the majority of surveyed people (95.5 percent) are satisfied from their job at a scale of medium to very strong, where in OECD countries about 83 percent of people are satisfied from their jobs (OECD, 2011). These obtained results show that external socio-economic factors may involve in personal satisfaction in the village, whereas the average monthly wage level across OECD countries (2,500 US dollars) in the year 2015 is approximately 6 times more than reported net rural income for the mazandran province (OECD, 2018). However, among the studied

group the majority of people mentioned that they are satisfied from their jobs.

Box 4-1 Earning and job assessment

Question 1 - What is the approximate level of your gross monthly income? Please select the level as: I have no income, less than 5,000,000 Riyal, 5,000,000 - 10,000,000 Riyal, 10,000,000 - 15,000,000 Riyal, 15,000,000 - 20,000,000 Riyal, and more than 20,000,000 Riyal.
Results:

- I have no income: 4.5 percent
- Less than 5,000,000 Riyal: 9.1 percent,
- 5,000,000 - 10,000,000 Riyal: 27.4 percent
- 10,000,000 - 15,000,000 Riyal: 31.8 percent
- 15,000,000 - 20,000,000 Riyal: 22.7 percent
- More than 20,000,000 Riyal: 4.5 percent

Question 2 - How much of your income goes to home expenditures like gas, electricity, sanitation and water supply? Please select the level as: less than 10 percent monthly, 10-20 percent monthly, 20-30 percent monthly, 30-40 percent monthly, more than 40 percent monthly.
Results:

- Less than 10 percent: 22.7 percent
- 10-20 percent :36.4 percent
- 20-30 percent: 36.4 percent
- 30-40 percent: 4.5 percent
- More than 40 percent: 0 percent

Question 3 - How much do you satisfied with your current job? Please select the level as very strong, strong, medium, weak, very weak, and I am dissatisfied with my current job.
Results:

- Very strong: 46.2
- Strong: 41.7
- Medium: 7.6
- Weak: 0 percent
- Very weak: 4.5 percent
- I am dissatisfied with my current job

4.4.3.3 Work-life balance assessment

The work-life balance assessment was conducted in working activities, non-working activities, and self-satisfaction with work-life balance aspects. The obtained results in each topic are presented in the following of this Section.

4.4.3.4 Time spent in working activities assessment

We asked from locals to evaluate their time spent in working activities and the results are presented as below.

Question - How much time do you allocate to work per day? Please select the level as: more than 10 hours, 8−10 hours, 6−8 hours, 4−6 hours, less than 4 hours, and I don't work. Or please select the level as very strong, strong, medium, weak, very weak, and I don't work.

Results:

- More than 10 hours: 11.1 percent
- 8−10 hours: 15.6 percent
- 6−8 hours: 40 percent
- 4−6 hours: 3.4 percent
- Less than 4 hours: 22.2 percent
- I don't work: 7.7 percent

Very strong: 0 percent

Strong: 30.7 percent

Medium: 23.1 percent

Weak: 38.5 percent

Very weak: 0 percent

I don't work: 7.7 percent

Interestingly, among the surveyed people who answered based on the qualitative scale (59.09 percent), nobody mentioned very strong choice, whereas 61.6 percent of people said that they have a work time at a scale of medium to weak. Only a few parentage of the surveyed people (11.1 percent), who answered based on hour's choices, expressed that they spend more than 10 hours per day for their work

activities. However, these obtained results is very close to the reported rate for OECD countries, where on average around 10 present of people work more than 10 hours per day (i.e. 50 hours per week) (OECD, 2010).

4.4.3.5 Non-working activities assessment

We asked from locals about their time spent in personal care, leisure, and domestic chore, whereas the results are present as below.

Question - How much time do you allocate to personal care (e.g. eating, sleeping, etc.) and leisure (e.g. socializing with friends and family, hobbies, games, computer and TV, etc.) per day? Please select the level as: more than 14 hours per day, 12−14 hours per day, 10−12 hours per day, 8−10 hours per day, and less than 8 hours per day. Or please select the level as very strong, strong, medium, weak, and very weak.

Results:

- More than 14 hours per day: 33.3 percent
- 12−14 hours per day: 22.3 percent
- 10−12 hours per day: 33.3 percent
- 8−10 hours per day: 11.1 percent
- Less than 8 hours per day: 0 percent

Very strong: 46.2 percent

Strong: 46.2 percent

Medium: 7.6 percent

Weak: 0 percent

Very weak: 0 percent

Question - How much time do you expend on domestic chores per day? Please select the level as more than 4 hours, 3−4 hours, 2−3 hours, 1−2 hours, and less than 1 hour. Or please select the level as very strong, strong, medium, weak, and very weak.

Results:

- More than 240 min: 11.1 percent — Very strong: 7.7 percent
- 180−240 min: 11.1 percent — Strong:7.7 percent
- 60−120 min: 22.2 percent — Medium: 38.4 percent
- 30−60 min: 44.5 percent — Weak: 46.2 percent
- Less than 30 min: 11.1 percent — Very weak: 0 percent

The results of non-working activities assessment in terms of time spent in personal care and leisure show that nobody among the surveyed people, who answered based on qualitative scale (i.e. 59.09 percent), selected very weak and week choices. This might have a link to their community strength, where a strong level of the social connections in this group is detected (see Section 2.4.9). Interestingly, all of the responders in this group thought that they spend time for their personal care and leisure at a scale of medium to very strong. In another group of the locals, who answered to the question based on hours choices, about 88.9 percent said that they spend more than 10 hours per day for their personal care and leisure, where the devoted time for personal care and leisure across the OECD countries is reported about 14.8 hours per day (OECD, 2011). Doing the routine house works, such as cleaning, are important parts in non-working activities assessment. The obtained results illustrate that the majority of the surveyed people (84.6 percent), who answered based on qualitative scale, mentioned that they spend time for their domestic chores at a scale of weak to medium. In another group of responders, who answered based on quantitative scale, majority of them (77.8 percent) said that they spend time for their routine housework less than 240 min per day, whereas the reported time spend across OECD countries is around 121 min per day (OECD, 2014).

4.4.3.6 Satisfaction with work-life balance assessment

As a part of work-life balance analysis, we asked from locals to judge about their work-life balance and the obtained results are present as below.

Question - How much do you satisfied with your work-life balance? Please select the level as very strong, strong, medium, weak, and very weak.

Results:
- Very strong: 46.2 percent
- Strong: 46.2 percent
- Medium: 7.2 percent
- Weak: 0 percent
- Very weak: 0 percent

The obtained results show that the majority of the surveyed locals (92.8 percent) are satisfied from their work-life balance at a scale of strong to very strong. However, a few people (7.2 percent) pointed out a medium level of satisfaction. A similar level of life-work balance in compare to OECD countries can be detected, where it is reported that people are highly satisfied (7.5 on the 0–9 scale) with their life-work balance (OECD, 2011).

4.4.4 Adult literacy rate assessment

The adult literacy rate was extracted in the selected villages from census records and the results are presented in Table 4-4. According to these extracted data, the Kandelous village has the highest adult literacy rate (89.21 percent) among the surveyed villages, whereas the lowest rate (66.83 percent) percent belongs to Nish Koh. The majority of the villages (i.e. except Nish Koh) have a similar ratio compared with the official literacy rate in the Mazandaran province, where the

ratio of 79.32 is reported (Statistical Center of Iran, 2011). These obtained results indicate a similar rate of literacy for both male (87.70 percent) and female (90.86 percent) groups in Kandelous, whereas in other villages generally the male group has a higher literacy rate in compared with female group. Zanous could be an exception to this trend, where the women group have about 20 percent higher literacy rate compared with the man group. Officially, few countries across OECD reported the literacy rates. However, according to UNSECO Institute for Statistics, the rate of 99 percent for adult literacy in central and eastern part of Europe (as a main part of OECD countries) can be detected with a similar pattern among both genders (UNESCO Institute for Statistics, 2013).

Table 4-4 Analysis of adult literacy rate in the region

		Kandelous	Zanous	Gila Kala	Nish Koh	Pideh
Adult population (above 6 years old)	Men	408	96	151	226	69
	Women	440	109	164	173	101
	Total	848	205	315	399	170
Literacy rate (percentage)	Men	90.86	80.20	94.04	57.08	92.75
	Women	87.70	66.05	79.87	79.19	88.12
	Total	89.21	72.68	86.67	66.83	90.00

As a whole, both genders have a similar ratio for their adult literacy in the Kandelous village, whereas a higher rate can be detected compared to other close villages. However, the obtained results are slightly below the estimated rate of 99 percent for central and eastern part of Europe.

4.4.5 Satisfaction with environmental quality assessment

The satisfaction with environmental quality is based on questions such as "*Are you satisfied (or dissatisfied) with the environmental quality?*" and answers are reported in yes/no categories. We asked

from local people to judge about their **air**, **water**, and **soil** quality and the obtained results are presented in Box 4-2.

Box 4-2 Satisfaction with environmental quality assessment

Question 1 - Are you satisfied with the quality of **air** in the village? If yes, please select the level as: very strong, strong, medium, weak, and very weak.
Results:

- Yes: 100 percent
- No: 0 percent

Very strong: 45.5 percent
Strong: 45.5 percent
Medium: 0 percent
Weak: 0 percent
Very weak: 0 percent

Question 2 - Are you satisfied with the quality of **water** in the village? If yes, please select the level as: very strong, strong, medium, weak, and very weak.
Results:

- Yes: 100 percent
- No: 0 percent

Very strong: 45.5 percent
Strong: 45.5 percent
Medium: 0 percent
Weak: 0 percent
Very weak: 0 percent

Question 3 - Are you satisfied with the quality of **soil** in the village? If yes, please select the level as: very strong, strong, medium, weak, and very weak.
Results:

- Yes: 100 percent
- No: 0 percent

Very strong: 45.5 percent
Strong: 35.5 percent
Medium: 10 percent
Weak: 0 percent
Very weak: 0 percent

The results show that all of the surveyed locals mentioned that they are satisfied with their water, air, and soil quality. However, less satisfaction with soil quality can be detected compare to water and air quality, whereas around 10 percent of the locals are satisfied with their

soil quality at a scale of medium (see Question 3 in Box 4-2). These obtained results should be highlighted, whereas among OECD countries about 70 and 80 percent of people are satisfied with their air and water quality, respectively (OECD, 2011). Moreover, there is no published data on level of satisfaction with soil quality in rural areas. Besides, soil degradation and soil erosion were reported in many places around the world (UN Environment Programme, 2007).

4.4.6 Self-reported heath status assessment

We asked locals to evaluate their health status based on the question "*How is your health status in general*?" and the results are present as below.

Question- How is your health status in general? Please select the level as: very good, good, medium, poor, and very poor.

Results:

- Very good: 31.8 percent
- Good: 54.6 percent
- Medium: 9.1 percent
- Poor: 4.5 percent
- Very poor: 0 percent

The obtained results indicate that more than 86 percent of the surveyed people said that they have a good to very good health status. While across OECD countries this rate reported about 68 percent (OECD, 2010). The results of a research project on health status in Netherland and US illustrated that about 77 and 62.7 percent of people in these countries are satisfied from their health status, respectively (Kapteyn et al., 2009). Thus, the observed rate in this study is slightly higher compared with these reported results. Interestingly, a few of the surveyed locals (i.e. 4.5 percent) selected the poor and very poor choices, which is very close to the reported data for the US (i.e. 3.5 percent), and slightly higher than Netherland (i.e. 1.4 percent)

(Kapteyn et al., 2009). This high level of health status might have a link to their happiness level (see Section 3.10), work-life balance (see Section 3.3), environmental quality (see Section 3.5) and other involved socio-economic parameters.

4.4.7 Personal security assessment

The feeling safe after dark on the street in the village was evaluated by locals through the question "*Are you feel safe on the street after dark*?", and the obtained results are presented as below.

Question - Do you feel safe on the street after dark in the village? If yes, please select the level as: very strong, strong, medium, weak, and very weak.

Results:

- Yes: 100 percent
- No: 0 percent

Very strong: 72.8 percent

Strong: 22.7 percent

Medium: 4.5 percent

Weak: 0 percent

Very weak: 0 percent

All of the surveyed people said that their village is safe after the dark for walking at a scale of medium to very strong. According to the reported value for this index, about 80 percent of people in OECD countries (on average) feel safe for walking alone at night (OECD, 2011). However, only 50 percent of people in Portugal, Greece, Hungary, and Luxembourg feel safe after dark. Moreover, it should be noted that most of people in the Kandelous village leave their door unlocked for several months during winter time and migrate to other places (Islamic Republic News Agency, 2014).

4.4.8 Trust in local government assessment

We asked from the local people to evaluate their trust in the local council and the results are presented as follow.
Question- How much do you have trust in the local council? Please select the level as: very strong, strong, medium, weak, and very weak.

Results:

- Very strong: 36.4 percent
- Strong: 36.4 percent
- Medium: 22.7 percent
- Weak: 4.5 percent
- Very weak: 0 percent

The results indicate that only a small amount of the surveyed people (4.5 percent) mentioned that they have a weak level of trust in their authority and the major part of surveyed people (more than 95 percent), said that they have a medium to very strong trust in the governmental unit. According to an unofficial report which was published by *Gallup World Poll*, across OECD countries only about 40% of people declared a high level of trust in their national government (OECD, 2011).

4.4.9 Social connections assessment

Trust in others, close social connection (e.g. having someone to count on in times of need), and time spent in volunteering activities were judged by locals and results are presented in Box 4-3.
The obtained results for evaluating the trust among local people (see Box 4-3, Question 1) show that all of the surveyed locals said that they have trust in other local people at a scale medium to very strong, whereas nobody mentioned weak and very weak choices. These obtained results illustrate a better level of trust among the community, whereas only about 33 percent of people have trust in each other

among OECD countries. The obtained results should be highlighted when a mutual trust is acknowledged as a necessary psychological precondition for building of a true friendship (Liang, J., Zhang J. , Zhang, 2000).

The social support analysis results indicate (see Box 4-3, Question 2) that all the surveyed dwellers know somebody who can help them and they will expect a strong to very strong level of help from their close social network. This obtained results should be highlighted when around 10 percent of people in OECD countries do not have a close social network support (OECD, 2011).

The results of time spent in volunteering activities analysis (see Box 4-3, Question 3) shows that all of the surveyed locals, who answered the question based on the qualitative scale (59.09 percent), thought that they spend time in volunteering activities at a scale of strong to very strong. However, only few among the responders (i.e. about 11 percent), who answered the question based on minute choices, said that they don't have time for doing volunteering activities. The majority of this group (i.e. about 90 percent) expressed that they allocate more than 10 minutes per day for volunteering activities, whereas the average time spent volunteering rate in OECD countries is about 4 minutes per day (OECD, 2011).

Box 4-3 Social connections assessment

Question 1 - How strongly do you trust in others in the village? Please select the level as: very strong, strong, medium, weak, and very weak.
Results:

- Very strong: 27.4 percent
- Strong: 63.7 percent
- Medium: 9.1 percent
- Weak: 0 percent
- Very weak: 0 percent

Question 2 - If you were in trouble, do you have relatives or friends you can count on to help you whenever you need them, or not? If yes, how strong do you evaluate their support?
Results:

- Yes: 100 percent
- No: 0 percent

Very strong: 45.5 percent
Strong: 50 percent
Medium: 4.5 percent
Weak: 4.5 percent
Very weak: 0 percent

Question 3 - How much time do you spend on volunteer activities for helping others? Please select the level as: more than 30 minutes per day, 20-30 minutes per day, 10-20 minutes per day, 5-10 minutes per day, and unfortunately, I don't have time for doing this. Or please select the level as: very strong, strong, medium, weak, and very weak.
Results:

- More than 30 minutes per day: 44.5 percent
- 20-30 minutes per day: 0 percent
- 10-20 minutes per day: 33.3 percent
- 5-10 minutes per day: 12.5 percent
- I don't have time for doing this: 11.1 percent

Very strong: 53.8 percent
Strong: 46.2 percent
Medium: 0 percent
Weak: 0 percent
Very weak: 0 percent

4.4.10 Self-reported happiness assessment

This index is based on evaluation of positive experiences (e.g. enjoyment, feeling well-rested, and smiling) in life. Thus, we asked from locals to evaluate their positive experiences in their life and the results are presented as below.

Question - How much do you have positive experiences such as enjoyment, smiling, laughing, and feeling well-rested during the day? Please select as: very strong, strong, medium, weak, and very weak.

Results:

- Very strong : 68.2 percent
- Strong: 27.3 percent
- Medium: 4.5 percent
- Weak: 0 percent
- Very weak: 0 percent

The obtained results show that about 95 percent of the surveyed people said that they have positive daily experiences at a scale of strong to very strong, which is a slightly higher (about 15 percent) in comparison with the reported data across OECD countries (OECD, 2011). Interestingly, nobody among the locals mentioned weak and very weak choices and this might have a link to their expectations from life and other socio-economic-environmental factors.

4.4.11 Self-reported life satisfaction assessment

This indicator is based on the question "*How much are you satisfied with your life in general?*" and we asked from locals to evaluate their life satisfaction, whereas the results are present as follow.

Question - How much do you satisfied with your life in general? Please select the level as: very strong, strong, medium, weak, very weak, and I am dissatisfied.

Results:

- Very strong: 40.9 percent
- Strong: 40.9 percent
- Medium: 18.2 percent
- Weak: 0 percent
- Very weak: 0 percent
- I am dissatisfied

The obtained results indicate that the majority of surveyed locals (about 82 percent) are strongly satisfied with their life, where, about 70 percent of people are satisfied from their life in OECD countries (OECD, 2011). Measuring National Well-being Office in UK observed that only 26.8% of British people are strongly satisfied with their life (UK Office for National Statistics, 2015). In addition, the results of a research project show that around 20 percent of people are strongly satisfied from their life in the Netherland and the US, whereas about 22 percent of people in the Netherland and US are dissatisfied from their life (Kapteyn et al., 2009).

4.5 Summery

The conducted assessment for the selected aspects of human well-being in the village show that all the surveyed people are happy and satisfied from their life and to some extent they have a better well-being status in terms of social connections, civic engagement, work-life balance, health, employment rate, and environmental quality in comparison to OECD countries. In spite of all of these domains, income and housing measures were detected relatively lower compared with OECD countries. However, these obtained results can be a proven to this statement that life is beyond the economic aspect, whereas the local people with a lower economic status are strongly satisfied and happy from their life. Perhaps, interpretation and expectation of the local people from their life have a key role in this

regard. Although, several socio-economic structures in the region are different from OECD countries. However, humanity has several similarities in common. Thus, we have made such as comparison between two different geographical places and among people.

Chapter 5 Land suitability analysis for creating *New Town* using AHP and GIS techniques

5.1 Introduction

In this Chapter, potential sites for creating *New Town* are investigated through AHP-GIS techniques. As it was discussed in **Chapter 1**, *New Town* settlements can be considered as small-scale Agro-based communities. Thus, the main focus of this Chapter is to evaluate the study area in terms of suitable sites for Agro-based communities with considering socio-economic-environmental aspects and in the context of sustainable organic farming (see **Chapter 2**). In this research organic farming was defined as "an integrated cultivation system with respect to people and environment". To do this assessment, several steps are considered in land suitability analysis framework including data collection and developing a GIS based analysis. This assessment is followed by a visualization step using high resolution satellite image to check the balance of decision. In addition, among counties in the study area, one county is selected as the highly suitable place and a field study survey is conducted at a county level.

5.2 History of organic agriculture in study area

According to an archaeological investigation, the first evidence of agriculture in Iran dates back to around 5000 B.C, when the domestic barley was cultivated in Tepe Sabz (located in the Kermanshah province), and it has recognized as one of Iranian national heritage sites of Iran (Flannery, 1973). Application of chemical fertilizers and pesticides in the agricultural practice of Iran were unknown before 1945, when the first chemical fertilizer was introduced to the national market by a financial support of the Agricultural Ministry of Iran. In addition, as a part of a FAO programme in 1950s, the Soil Fertility

Research Centre of Iran was established in 1954 to encourage farmers, who were against the chemical fertilizers in that time, for implementation of the chemical fertilizers such as potassium nitrate, phosphate, and ammonium sulphate. Subsequently, in the year 1955, the first chemical fertilizer cargo (e.g. 100 tons of nitrate, 100 tons of ammonium sulphate and 50 tons of triple superphosphate) were imported to Iran (Karimiyan, 2010). Unfortunately, due to non-sustainable agricultural practice, the recent statistics illustrate that annually about 3.5 million tonnes of chemical fertilizers are used in the agricultural sector of Iran. Moreover, this high rate of chemical fertilizers in Iran is associated with a high rate in implementation of pesticides, whereas more than 27,000 tonnes of pesticides were applied in the year 2001 (Department of Environment of Iran, 2010).

Nowadays, several socio-economic factors including public awareness about the side effects of pesticides and chemical fertilizers, have made some changes in the strategic agricultural plan of Iran to produce more healthy and organic food. Furthermore, the benefits of organic farming are broadly appreciated by Iranian policy makers, planners, and scholars (Malek-Saeidi, Rezaei-Moghaddam, & Ajili, 2012). The roots of this modern organic agriculture movement in Iran can be traced within universities at the lectures of Professor Koocheki at Ferdowsi University of Mashad during the 1990s. Subsequently, in the mid-2000s, the Shahid Beheshty University introduced a mater program in Agroecology. Parallel to this academic development, on the private sectors side, several NGOs such as Iranian Scientific Society of Agroecology (ISSA) and Iranian Organic Association (IOA) were established in 2005 and 2006, respectively. The both aforementioned NGOs have had positive influences on the legislation of the Iranian standard or organic farming.

Since 2006 Iran has been recognized as an exporter for the organic produces, where the first exported organic products have been recorded as pomegranate, figs, dates, and medicinal herbs. According to an estimate, around 95 per cent of Iranian organic products were

exported to the European Union, in the year 2010 (FiBl & IFOAM, 2013). A rapid increase in organic farming can be detected in Iran, whereas the reported cultivated organic areas in 2016 (11,601 ha) compared to the year 2010 shows around 37 per cent expansion. The main organic productions can be listed as pistachio (1382 ha), wheat (1156 ha), rose (900 ha), fig (780 ha), raisin (700 ha) and date (595 ha) (Malek-Saeidi et al., 2012). Despite the aforementioned changes in organic farming, the ratio of cultivated organic farms to the total agricultural land use is less than 1 per cent for the years 2013/2014 (Ministry of Agriculture Jihad of Iran, 2014).

5.3 Materials and methods

The overall methodology involves the following major steps as: 1) data collection, 2) generation of criterion maps 3) standardization of criterion maps in raster-based format, 4) hierarchy structure and weighting AHP, 5) Weighted Overlay Analysis (WOA), and 6) Validation (Visualization and field study) . Figure 5-1 shows the methodology flowchart.

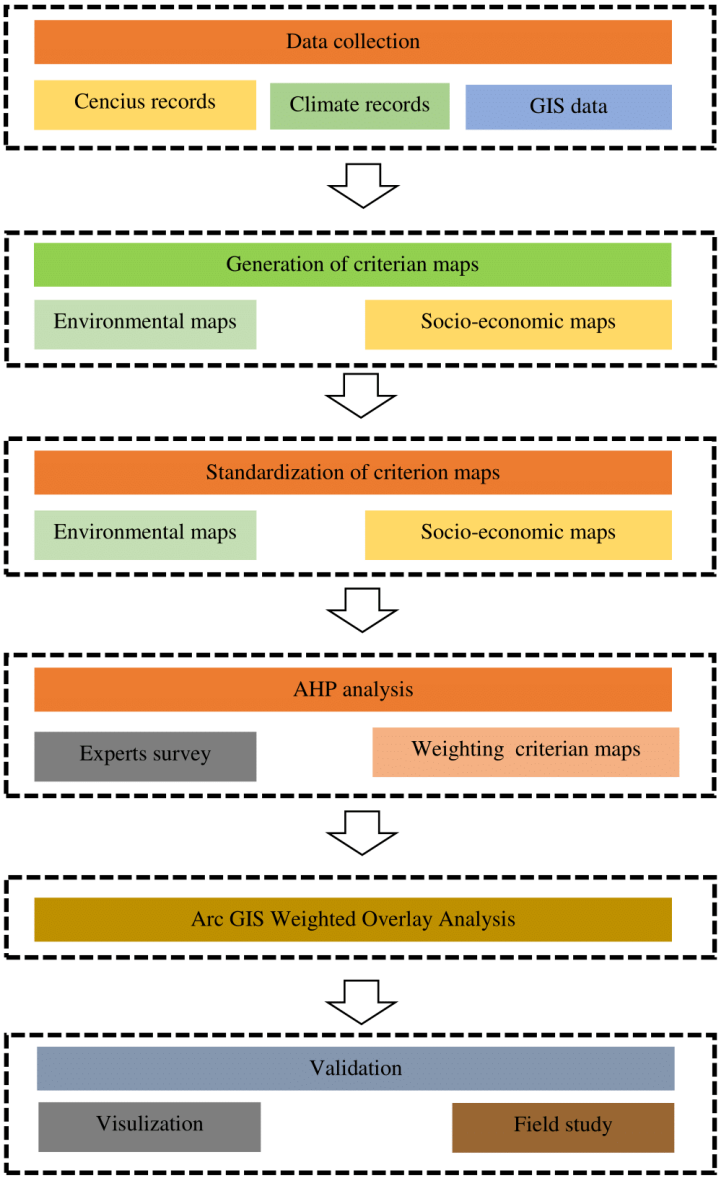

Figure 5-1 Methodology flowchart

5.3.1 Selected parameters

Several constrains and criteria were selected in this study in social, economic and environmental aspects in order to establish an integrated socio-economic-environmental assessment. The environmental criteria were chosen based on the main components in farming as: access to water, geology and soil type, and solar radiation. Thus, on environmental side, following criteria were selected: precipitation, distance to rivers, temperature, humidity, slope, aspect, elevation, geology, soil type, sunshine, and climate type. On socio-economic side, four main criteria were chosen as: distance to cities, distance to major roads, distance to electrical grids, employment rate, rural population growth rate, and density rate. To obtain the aforementioned criteria, different types of data were used in this study as listed in Table 5-1.

Table 5-1 Parameters and datasets used in the land suitability analysis

Parameters and maps	Data type and original format	Details about data	Period
Slope, elevation, aspect	Spatial- SRTM DEM	3-ARC (30 m)	2009
Land use-land cover map	Spatial- Digitized feature	-	2016
Soil type and geology maps	Spatial- Digitized feature	-	2008
Rivers map	Spatial- Digitized feature	-	2009
Roads map	Spatial- Digitized feature	-	2010
Electrical grids map	Spatial- Digitized feature	-	2008
Political divisions map	Spatial- Digitized feature	-	2016
Population records	Non-Spatial, Microsoft Excel	Extracted for 119 counties	2011
Employment records	Non-Spatial, Microsoft Excel	Extracted for 119 counties	2011
Climate records	Non-Spatial, Microsoft Notepad	Extracted for 14 synoptic stations	2006–2014
Protected area	Spatial- Digitized feature	-	2010

5.3.2 Land suitability classification

Land suitability categories express whether a place is evaluated as suitable or non-suitable for the organic farming. This classification was adopted in this study from FAO general framework for land suitability evaluation (1976). According to this framework, two main orders are used represented by the symbol S and N, whereas the classes (i.e. 1, 2 and 3 for suitable and; 1 and 2 for unsuitable order) illustrate the degree of suitability or non-suitability, as shown in Table 5-2.

Table 5-2 Applied land suitability classification (FAO, 1976)

Order	Class	Description
Suitable	S1 (Highly suitable)	Land having no, or insignificant limitations to the given type of use
	S2 (Moderately suitable)	Land having minor limitations to the given type of use
	S3 (Marginally suitable)	Land having moderate limitations to the given type of use
Non-suitable	N1 (Currently not suitable)	Land having severe limitations that preclude the given type of use, but can be improved by specific management
	N2 (Permanently not suitable)	Land with so severe limitations which are very difficult to be overcome

5.3.3 Generation of criterion maps using geospatial techniques

Elevation (Figure 5-11), slope (Appendix 5), and aspect (Appendix 5) maps were generated using Shuttle Radar Topography Mission (SRTM) near-global Digital Elevation Models (DEMs) data of 30 m resolution obtained from United States Geological Survey (USGS). Geology (Appendix 5) and soil (Appendix 5) maps were obtained from Geological Survey and Mineral Explorations of Iran (GSI). Political (Appendix 1), land use-land cover (LULC) (Appendix 5), electricity grid (Appendix 5), roads (Appendix 5), and rivers

(Appendix 5) maps were derived from the National Cartographic Centre of Iran (NCC), the Iranian Space Agency (ISA), the Mazandaran Regional Electric Company, the Mazandaran Department of Roads and Urban Development, and the Mazandaran Regional Water Authority, respectively.

5.3.4 Generation of Aspect-Slope Map

Aspect-slope map was computed in this study in order to show simultaneously the aspect (direction) and degree of slope (steepness) of the region in a single map. To do this, first the both slope and aspect maps (obtained from DEMs) were reclassified into 6 different steepness grades (less than 10%, 10−15%, 15−20%, 20−25%, 25−30%, and more than 30%) and 4 different directions classes (N, E, S,W), as shown in Table 5-3. The applied classification classes were also used in other land suitability analysis studies for assessing agricultural lands (Akinci et al., 2013; Y. Chen, Yu, & Khan, 2010; Elsheikh et al., 2013; Gaden, Choden, & Tschomo, 2015; Widiatmaka et al., 2016).

Table 5-3 Selected slope-aspect classification

Class number	Aspect-Slope type
1	Flat, (N, E, S, W) (<10%)
2, 3, 4, 5	N (10−15%), E (10−15%), S (10−15%), W (10−15%)
6, 7, 8, 9	N (15−20%), E (15−20%), S (15−20%), W (15−20%)
10, 11, 12, 13	N (20−25%), E (20−25%), S (20−25%), W (20−25%)
14, 15, 16, 17	N (25−30%), E (25−30%), S (25−30%), W (25−30%)
18	(N, E, W, S) (>30%)

To compute the aspect-slope map, two steps were applied. First, both aspect and slope maps (obtained from DEMs) were categorized according to the selected classes (see Table 5-3), by ArcGIS Reclassify toolbox. Second, to unify the obtained maps from the first step, ArcGIS Raster Calculator toolbox (see Section 05.3.16) was

used as shown in Figure 5-2. The calculated aspect-slope map is present in Figure 5-10.

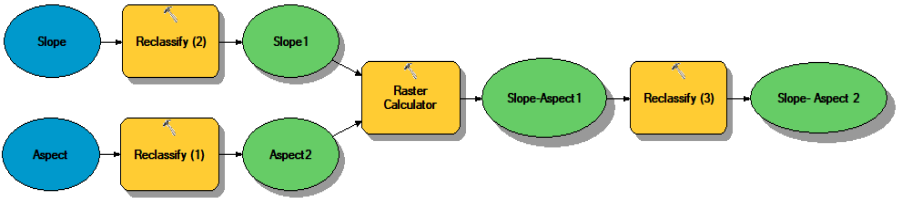

Figure 5-2 Applied syntax in Model Builder ArcGIS toolbox for generating aspect-slope map

5.3.5 Generation of climate maps

Agriculture is highly dependent on the climate. Thus, several climate indexes were considered in this investigation in order to have a comprehensive assessment at the study area. The climate data in the province are recorded by 14 synoptic stations (Appendix 2, Appendix 3), whereas all of these stations were established after the year 2006. Thus, the period of 2006−2014 was selected to include all available records. As shown in Figure 5-3, several steps were taken in order to generate climate maps for the study area. First, the monthly records for all parameters (i.e. precipitation, temperature, relative humidity, and sunshine) were extracted from the Iran Metrological Organization database. Second, based on the monthly records, the annual values were calculated by Microsoft Excel software for each parameter in the stations. Third, the Inverse Distance Weighed method (IDW) was applied as a spatial interpolation method to convert point data to raster data format (see Section 5.3.6). Finally, the obtained precipitation and temperature maps were used to determine the type of climate by using the aridity index of De Marttonne (IDM) (see Section 5.3.7).

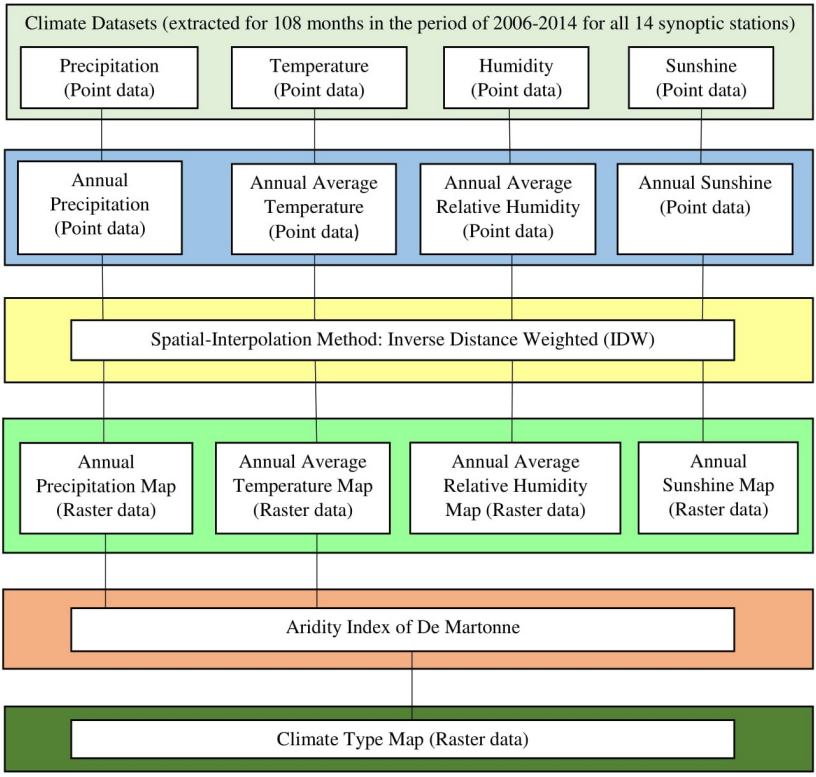

Figure 5-3 Schematic process used for generating climate maps

5.3.6 Inverse Distance Weighed method

The inverse distance weighting or inverse distance weighted (IDW) method was developed by U.S. National Weather Service in 1972 and is considered as a deterministic method (F. W. Chen & Liu, 2012). The principle of the IDW is based on Tobler's first law (the first law of geography) from 1970, which says "*everything is related to everything else, but near things are more related than distant things*". In general, this method is used for estimating the value of an attribute at non-measured points in a given area, whereas sample points are

known values as scattered set of points (see Figure 5-4). The principle of this evaluation is derived from a linear combination of values at sampled points weighted by an inverse function of the distance from the point of interest to the sampled points. The weights are defined as:

$$w_i = \frac{1/d_i^p}{\sum_{i=1}^{n} 1/d_p^i} \qquad \text{Equation 5-1}$$

where, d_i is the distance between x_0 and x_i, p is a power parameter (the most popular choice of p is 2), and n represents the number of sampled points used for the estimation. Thus, the interpolated value at a given point x based on samples $u_i = u\ (x_i)$ for i =1, 2…, n; can be expressed by the following equation:

$$u\ (x) = \frac{\sum_{i=1}^{n} wi(x)\ ui}{\sum_{i=1}^{n} wi\ (x)} \qquad \text{Equation 5-2}$$

where, $u\ (x)$ is the interpolated value at a given point x, and w_i values are calculated from Equation 5-1. In the present study the p value was assumed as two, similar to the p value used by (Huiyi & Shaofeng, 2004; Lin, XS., Yu, 2008).

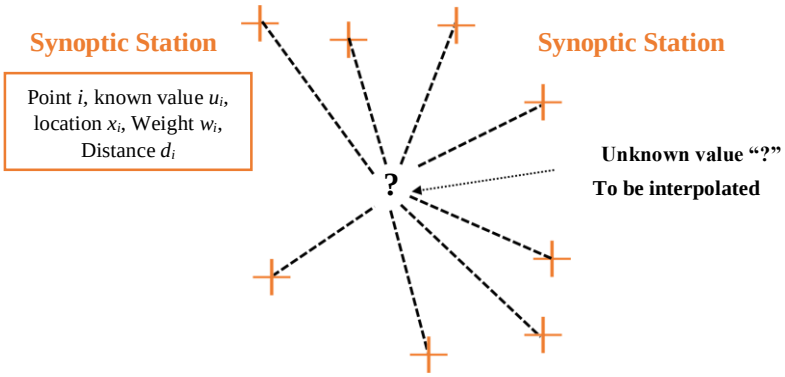

Figure 5-4 Inverse Distance Weighted interpolation based on weighted synoptic stations distance

5.3.7 Aridity index of De Martonne

Aridity is defined as the shortage of moisture that is depended on average climate conditions in a given region (Agnew and Anderson 1992). The aridity index of De Marten (I_{DM}) is applied wieldy in both climatology and meteorology studies to identify dry/humid weather conditions (Coscarelli et al. 2004; Baltas 2007; Shahid 2008, 2010; Zarghami et al. 2011; Adnan and Haider 2012). Thus, the I_{DM} was selected to classify the climate in the province of Mazandran, whereas the I_{DM} can be expressed by the following formula (De Martonne E., 1925):

$$I_{DM}=\frac{P}{T+10} \qquad \text{Equation 5-3}$$

where *P* and *T* are the annual amount of precipitation and mean annual temperature in millimetre and in degree Celsius, respectively. The calcification of climate is conducted by the obtained values from Equation 5-3 and according to the defined ranges as shown in Table 5-4.

Table 5-4 De Martonne index climatic classification (Croitoru, Piticar, Imbroane, & Burada, 2013)

Climate	Values of IDM
Arid	$I_{DM}<10$
Semi-arid	$10\leq I_{DM}<20$
Mediterranean	$20\leq I_{DM}<24$
Semi-humid	$24\leq I_{DM}<28$
Humid	$28\leq I_{DM}<35$
Very humid	$35\leq I_{DM}\leq 55$
Extremely humid	$I_{DM}>55$

In the present study, the De Martonne index was calculated through several steps in the ArcGIS software. First, all precipitation and temperature data were converted to the raster format type. Second, to undertake a cell-by-cell analysis (see Figure 5-5), the I_{DM} formula was

coded in the Map Algebra (as a part of ArcGIS Spatial Analyst toolbox) as schematically illustrates by Figure 5-5.

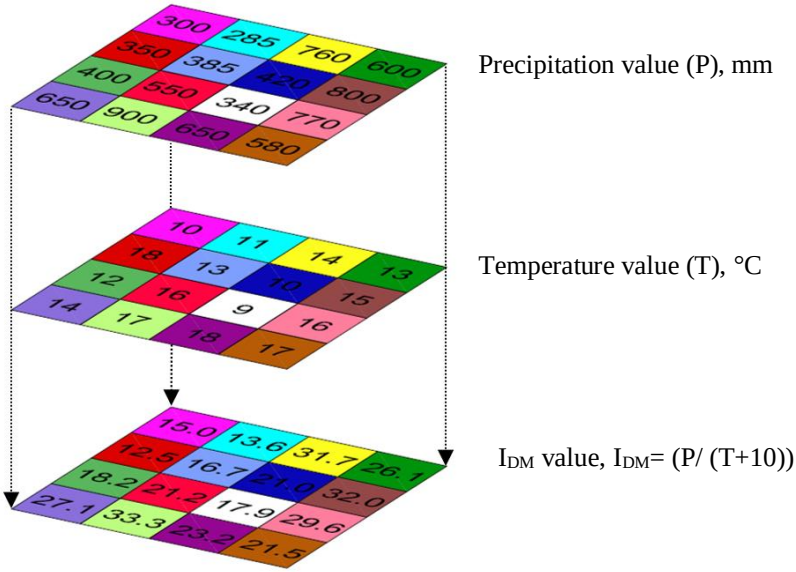

Figure 5-5 Schematic cell-by-cell simulation used in Algebra Map to calculate the I_{DM} Index

5.3.8 Generation of socio-economic criterion maps

As shown in Figure 5-6, a number of different approaches are taken in ArcGIS and Microsoft Excel to generate the criterion maps for the selected socio-economic aspects. First, the population (for the years 2006 and 2011) and number of employed people (for the year 2011) were extracted in all settlements from national census datasets. The annual population growth and employment (calculated for the year 2011) rates,

$$P_x = \frac{\sum_{i=1}^{m}(\frac{P2_i - P1_i}{P1_i} \times 100)/N)}{m}, x = 1, 2 \ldots, 119 \qquad \text{Equation 5-4}$$

$$E_x = \frac{\sum_{i=1}^{m}((\frac{Li}{Pi}) \times 100)}{m}, x = 1, 2 \ldots, 119 \qquad \text{Equation 5-5}$$

were formulated in an Excel datasheet. In Equation 5-4, *P* is the annual population growth rate, *x* the index of county, *i* the index of settlement, *P2* the current population record (i.e. here for the year 2011), *P1* the past population record (i.e. here for the year 2006), and *N* the number of years between two periods (here as 5 years for the period 2006−2011). In Equation 5-5, *E* is the employment rate, *x* the index of county, *i* the index of settlements, *m* the number of settlements, *L* the number of employed people (calculated for the population aged 10 years and over), and *P* the current population record. All obtained values from the Equation 5-4 and Equation 5-5 were inserted into ArcGIS for all counties in the province. In addition, the population density ratio,

$$D_x = \sum_{i=1}^{m}\left(\frac{P_i}{Si}\right), \quad x = 1,2, \ldots,119 \qquad \text{Equation 5-6}$$

was coded in ArcGIS Field Calculator toolbox. In Equation 5-6, *D* is the population density ratio in persons per Km^2, *x* the index for county, i the index for settlement, *m* the number of settlements, *P* the population record (i.e. here for the year 2011), S_i the surface area of county (calculated from the political map by the Calculate Geometry toolbox in ArcGIS). Finally, the ArcGIS Spatial Analysis (see Section 5.3.9) was applied to calculate the distance to rivers, roads, electrical grids, cities, and villages.

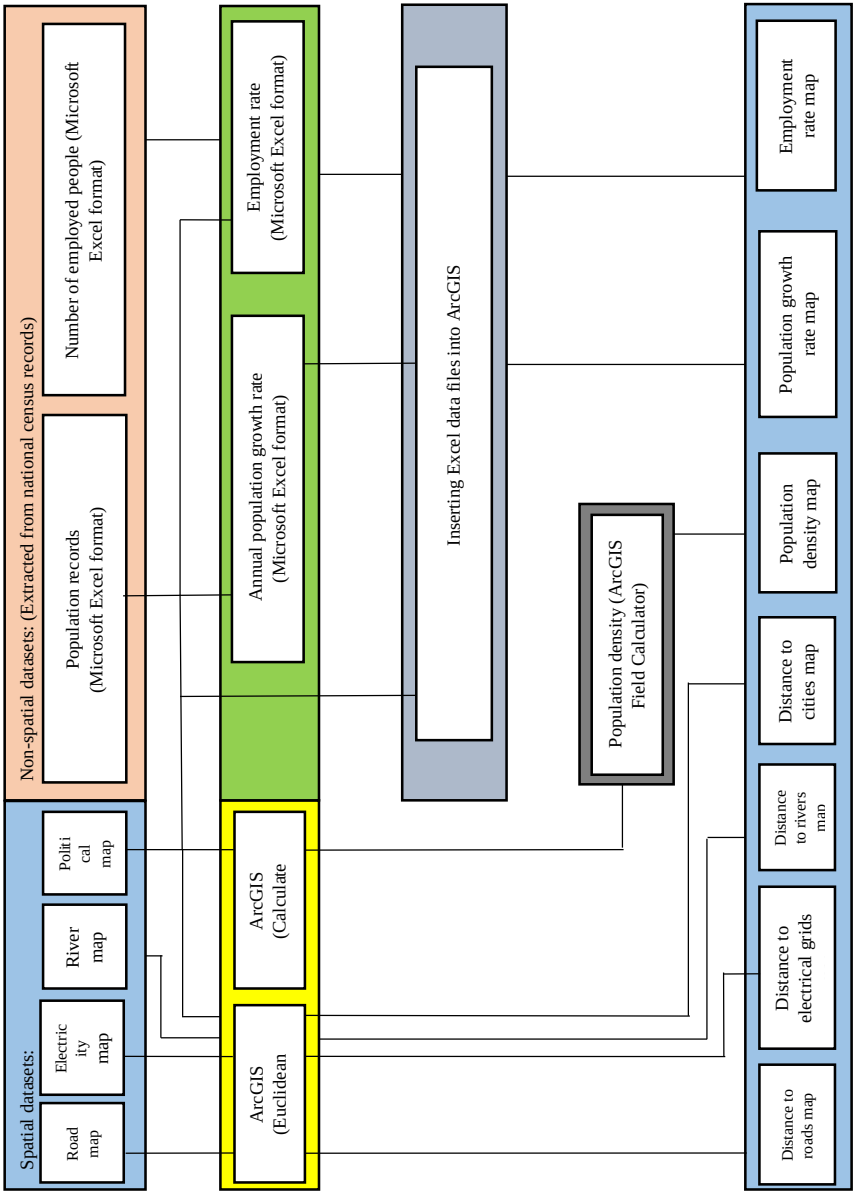

Figure 5-6 Schematic process used for generating socio-economic criterion maps

5.3.9 ArcGIS Euclidean Distance

The distance between two locations is assessed by using the Euclidean distance, whereas this is defined as: half the difference squared between the pairs of locations (the y-axis) is plotted relative to the distance that separates them (the x-axis). In other words, If the points (x_i, y_i) and (x_j, y_j) are in 2-dimensional space, then the Euclidean distance (d_{ij}) expressed as:

$$d_{ij} = \sqrt{(xi - xj)^2 + (yi - yj)^2} \qquad \text{Equation 5-7}$$

The above mentioned concept is applied in ArcGIS as the toolbox, as a as a part of the Spatial Analysis. This toolbox can facilitate the calculation, on a cell-by-cell basis, by creating a grid. In this grid, the source locations must have the valid values and other points (i.e. cells) should have no data. Thus, the value 0 is considered as a legitimate source (see Figure 5-7) and the distance of other points are calculated to these sources. The Figure 5-7 illustrates how the ArcGIS Euclidean Distance calculate assesses a raster data on a cell-by-cell basis.

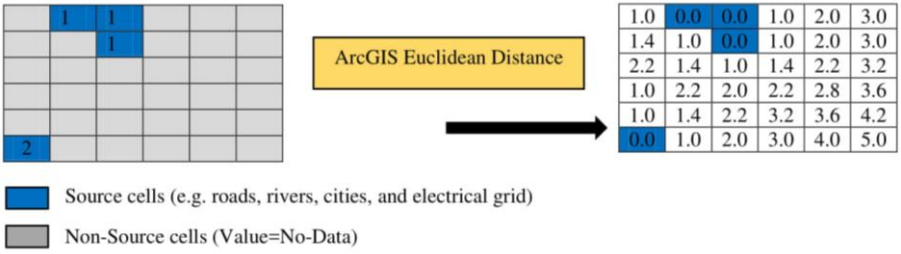

Figure 5-7 Schematic applied principle in ArcGIS Euclidean Distance for calculating cell-by-cell analysis

5.3.10 Standardization of selected criteria maps

All of the selected criteria maps should be in same unit to run Weighted Overlay Method. Thus, the standardization of maps was conducted in two main steps as follow: 1) all vector layers was converted to raster type, and 2) all raster data were reclassified by Reclassify method in spatial analyst toolbox of ArcGIS software.

5.3.11 Calculation of AHP weight for each criterion

To calculate AHP weights, all selected criteria maps were compared in pairs by using the Saaty's semantic 9-point scale, where 9 demonstrates extreme significance and 1 indicates the equal significance between criterion maps, as shown in Table 5-5 (Feizizadeh et al., 2014; Malczewski, 2006; Saaty, 2008). To do this pairwise comparison, an experts survey was conducted as explained in Section 5.3.12 .

Table 5-5 The applied pairwise comparison scale (Saaty, 2008)

Importance rank	Linguistic definition	Explanation
1	Equal importance	Two criteria contribute equally to the objective
3	Moderate importance	Judgments and experience slightly favor one criteria over another
5	Strong importance	Judgments and experience strongly favor
7	Very strong importance	Criterion is strongly favored and its dominance is demonstrated in practice
9	Extreme importance	Importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate vales used to represent compromise between the priorities listed above	

Using the 9-point scale (see Table 5-5), the following comparison pairwise matrix A is created, which contains the relative weights for the criteria maps.

$$A = \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \vdots & \vdots & & \vdots \\ \frac{w_i}{w_1} & \frac{w_i}{w_2} & & \frac{w_i}{w_n} \\ \vdots & \vdots & & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & & \frac{w_n}{w_n} \end{pmatrix} \qquad i = 1, 2 \ldots n \qquad \text{Equation 5-8}$$

where w_i is the importance weight of the *i*th criteria with respect to the land suitability assessment. In addition, the importance weights can be calculated using the following equation (Saaty, 2008).

$$Aw = \mu_{max}\, w \qquad \text{Equation 5-9}$$

where μ_{max} is the maximum eigenvalue of the matrix and $w = (w_1 \ldots w_n)$ is the corresponding eigenvector of A. The procedure is repeated for each level, until the top of the hierarchy is reached. In addition to all aforementioned stages, as an important part of AHP method, the inconsistency analysis needs to be done. To estimate this, the Constancy Index (CI) and the consistency relationship are defined by Equation 5-10 , and Equation 5-11, respectively (Feizizadeh et al., 2014; García et al., 2014; Saaty, 2008).

$$CI = \frac{\mu_{max} - n}{n-1} \qquad \text{Equation 5-10}$$

$$CR = \frac{CI}{RI} \qquad \text{Equation 5-11}$$

where n is number of components (i.e. here number of maps) in pairwise comparison matrix, RI the Random Index, and μ_{max} as defined in Equation 5-10. The Random Index has been proposed (Alonso & Lamata, 2006) for various n, which is 1.6181 for n=17 (number of maps). If, the value of CR >0.10 then the weight values of the matrix shows inconsistencies and some other processes (such

as re-comparison or mathematical linearization) is needed in order to reach to a meaningful results (Benítez, Delgado-Galván, Gutiérrez, & Izquierdo, 2011). In the present study, the weighted geometric mean method is used for aggregating individual judgment matrices to obtain a collective judgment matrix as a group decision making process (Dong, Zhang, Hong, & Xu, 2010).

5.3.12 Expert survey

The weighting process was carried out using a group of expert that consists of 15 experts (e.g. academics, environmental planners, agricultural engineers, and town planners), who specialized in different fields related to rural development. All experts were invited to make their pairwise comparison judgments on selected criteria (Appendix 4) and rank their priority for land suitability analysis by filling out a carefully designed questionnaire. Table 5-6 shows the classification of the respondents group.

Table 5-6 Classification of experts survey

Major	Number of experts
Agricultural engineering	3
Environmental planning	2
Landscape architecture	3
Civil and environmental engineering	2
Town planning	3
Social policy and public service planning	2
Total	15

5.3.13 Weighted Overlay Analysis

The weighted overlay analysis is an effective tool to resolve spatial complexity in land suitability analysis (Girvan, Bullimore, Pretty, Osborn, & Ball, 2003; Kuria, Ngari, & Waithaka, 2011). All the calculated AHP weights were allocated to the attribute raster layers in

order to perform WOA analysis (Equation 5-12), whereas each cell from each map layer must be reclassified into a common priority scale, here as 1–9, with 9 being the most favorable. The WOA can be express by Equation 5-12.

$$LS = \frac{\sum W_i S_{ij}}{\sum W_i} \qquad \text{Equation 5-12}$$

where L*S* is the spatial land suitability value in output map, *Wi* is the weight ith criterion map, and S_{ij} is the *i* th spatial class weight of *j* th factor map. All calculation steps were conducted in the Model Builder Toolbox of ArcGIS 10.2.

5.3.14 Exclusion of protected areas

As shown in Appendix 5, the study area has several protected areas including national park, wildlife refuge area, wetland, and environmental protected area. All protected areas (i.e. national parks, wildlife refuge areas, natural monuments, and protected areas) with the selected distance buffers (see Table 5-7), were excluded in this study through several steps. First, the Buffer Analysis was conducted for all protected area categories to create a buffer distance from the protected areas. Second, since the geographic coordinates of the protected areas were addressed in the official collected maps, the political border of the study area needs to be integrated as well. To do this, all obtained maps from the first step were combined with the political border map of the study area through the Union ArcGIS toolbox. Third, all generated maps from second step were converted to Raster data type by using Feature to Raster Conversion Toolbox ArcGIS. Fourth, conditional evaluations were implemented through Map Algebra-ArcGIS Con toolbox (5.3.15) to exclude the protected areas. Fifth, to combine all generated maps from the fourth step, Map Algebra-Raster Calculator toolbox (see Section 0) was applied.

Finally, the obtained map from the fifth step was unified with the calculated land suitability map using same by ArcGIS Raster Calculator toolbox. Figure 5-9 illustrates the applied process in Model Builder ArcGIS to formulate all aforementioned steps to combine all protected areas and selected buffer distances.

Table 5-7 Applied buffer distance ranges to protected areas

Restriction type	buffer distance (m)*	selected buffer distance (m)
National park	150−2,000	2,000
Wildlife refuge	150−1,000	1,000
Environmental protected area	150−1,000	1,000
Natural monument	150−2,000	2,000

* Extracted from Department of Environment of Iran (2010)

5.3.15 ArcGIS Con toolbox

The Con function is used to evaluate the output value for each cell based on true or false conditional statement. In this study this conditional statement was defined as follow: If the cell evaluates to true (i.e. here as restricted area), it will receive zero value; otherwise one value will assigned to the cell. Figure 5-8 demonstrates how ArcGIS Con toolbox is formulated for the aforementioned conditional statement.

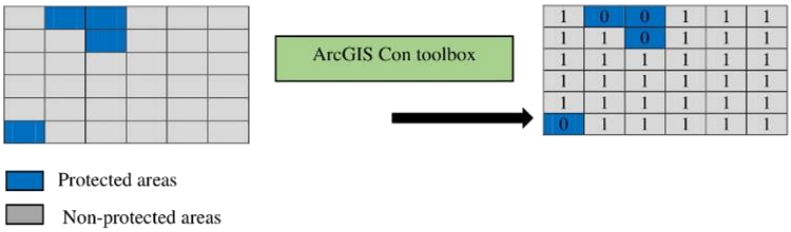

Figure 5-8 Schematic of applied principle in ArcGIS Con toolbox for assigning zero value to all protected areas

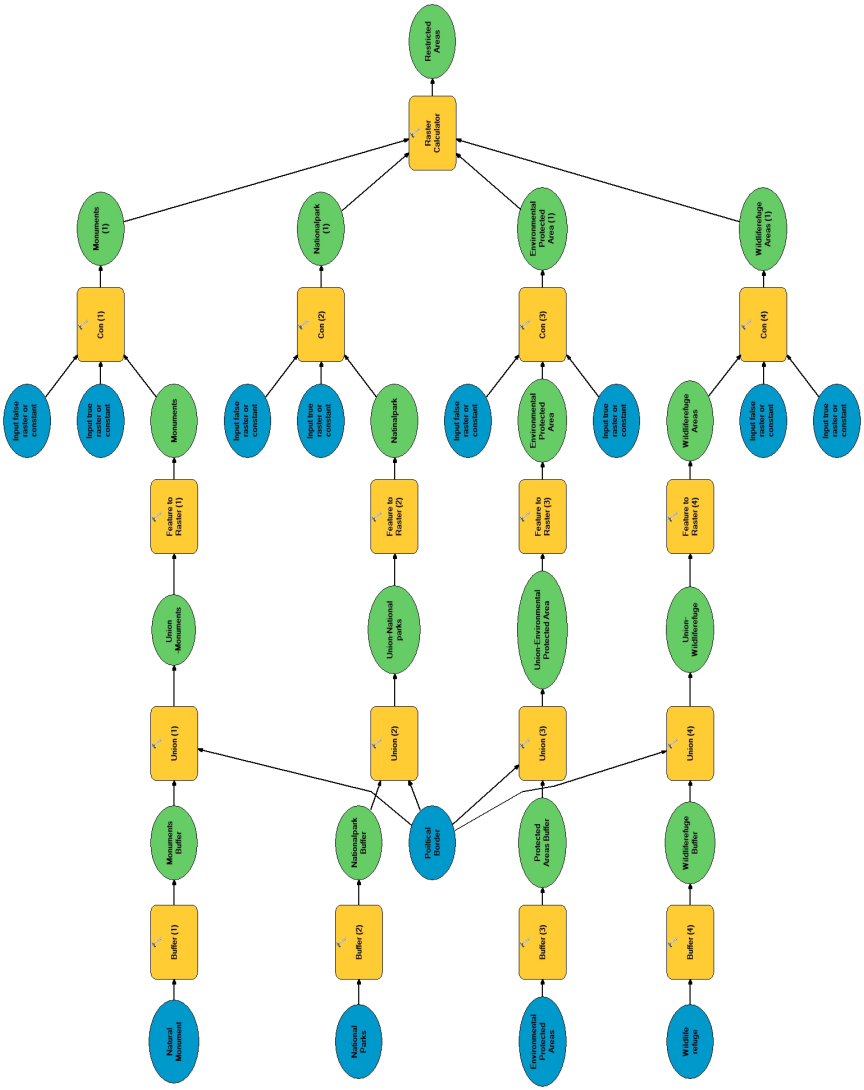

Figure 5-9 Applied map algebra process in Model Builder ArcGIS toolbox for excluding protected area

5.3.16 ArcGIS Raster Calculator

The Raster Calculator tool can be used to run spatial analysis by defining expressions in Python syntax programing language. To combine all generated maps obtained from ArcGIS Con step, the Raster Calculator tool was used by defining following expression:

$$P_A = P_{CON-E} \times P_{CON-N} \times P_{CON-W} \times P_{CON-M} \quad \text{Equation 5-13}$$

Where P_A is the accumulative protected areas layer, $P_{CON\text{-}E}$ the ArcGIS Con environmental protected area layer, $P_{CON\text{-}N}$ the ArcGIS Con national park layer, and $P_{CON\text{-}W}$ the ArcGIS Con wildlife refuge area layer, and $P_{CON\text{-}M}$ the ArcGIS Con natural monuments layer.

5.3.17 Validation of model

In order to check the balance of proposed decision support model, the obtained results were validated by two main steps as: 1) visualization by Google Earth, and 2) field study survey.

5.3.17.1 Visualization

In the present study, distribution of existing farming lands among the suitability classes (see Table 5-2) was assessed by randomly checking the 2400 square kilometer (approximately 10 percent of the total study area) of lands with the obtained Google Earth image. This visualization technique was applied in other land suitability analysis (Mesgaran, Madani, Hashemi, & Azadi, 2017). To do this visualization assessment, three main steps were taken as described at the following. First, the computed land suitability map was converted to the KML format type with ArcGIS Conversion Tools. Second, the KML format (i.e. geo-referenced layer) was overlaid in the Google

Earth by Image Overlay tool with the aforementioned satellite image. Third, on a cell-by-cell basis, the percentage of farming land occupied in each image was visually estimated. Fourth, the evaluated percentage farming in each randomly selected cell was summed up and the mean value was calculated for suitability classes.

5.3.17.2 Field study

In this research, we decided to limit the field study step to the top ranked county, whereas a multidisciplinary approach was developed to describe and identity the current socio-economic-environmental characteristics of the selected county. To do this, first all selected criterion maps were extracted for this county. Besides, the extracted political border of this county was converted to KML format. Second, the generated KML format was integrated with high resolution image that obtained from the Google Earth. Finally, a visit from the selected county also was conducted at the beginning of December 2017 including interviews with locals.

5.4 Results and discussion

This Section is divided into three main parts: 1) analyzing the calculated AHP weights, 2) analyzing the generated environmental-socio-economic criterion maps and 3) analyzing the obtained land suitability map.

5.4.1 Analysing of calculated AHP weights

The AHP technique was used to evaluate and weight the selected criterion maps. In order to determine the criteria weights, pairwise comparison was taken based on the expert questionnaire as demonstrated in Section 5.3.12. Due to the time limitation, the expert survey was conducted with 15 people (see Table 5-6) who responded

within a set of time frame of one month. On basis of these collected questionnaires, the weighted geometric mean method was applied to aggregate all collected individual judgments, whereas the aggregated results are presented in Table 5-8. Afterwards, the conducted inconsistency relationship analysis was conducted, the computed inconsistency (0.027) was detected below than 0.1. Thus, the AHP judgements are reliable. After this validation step, all weights were converted into percentage priority for the Weighted Overlay Analysis (WOA) as shown in Table 5-9.

According to the obtained priority results (see Table 5-9), the selected environmental (i.e. Slope-Aspect, elevation, geology, temperature, climate type, precipitation, humidity, and sunshine), and socio-economic (i.e. LULC, distance to city, distance to river, distance to road, distance to electrical grid, population density rate, employment rate, and population growth rate) aspects were recognized as dominant criteria with the influence factor of 47% and 53%, respectively. While LULC and Aspect-Slope maps are the most dominant criteria among the selected maps. In contrast, humidity with the influence factor of 2 percent is the least importance.

Table 5-8 Obtained AHP pairwise comparison matrix

Map	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1	4	5	2	3	3	2	2	3	3	3	2	2	1	1	1	3
2	0.3	1	2	0.3	0.5	0.5	3	0.5	1	1	0.5	0.5	0.5	0.3	0.5	0.3	1
3	0.2	0.5	1	0.3	0.5	0.5	1	0.3	0.5	0.5	0.5	0.2	0.3	0.3	0.2	0.3	0.3
4	0.5	3	3	1	2	2	4	0.5	2	2	2	1	1	0.5	0.5	0.5	1
5	0.3	2	2	0.5	1	0.5	2	0.3	0.5	0.5	0.5	0.5	0.5	0.3	0.5	0.3	1
6	0.3	2	2	0.5	2	1	3	0.5	1	1	1	0.5	0.5	1	0.3	0.5	1
7	0.5	0.3	1	0.3	0.5	0.3	1	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.3	0.3	0.3
8	0.5	2	3	2	3	2	4	1	2	2	2	1	2	0.5	1	1	2
9	0.3	1	2	0.5	2	1	3	0.5	1	1	1	0.5	1	0.3	0.5	0.5	1
10	0.3	1	2	0.5	2	1	3	0.5	1	1	1	0.5	1	0.3	1	0.3	1
11	0.3	2	2	0.5	2	1	3	0.5	1	1	1	0.5	0.5	0.5	0.5	0.5	1
12	0.5	2	4	1	2	2	4	1	2	2	2	1	2	0.5	1	0.5	2
13	0.5	2	3	1	2	2	3	0.5	1	1	2	0.5	1	0.5	2	0.5	2
14	1	3	4	2	3	1	7	2	3	3	2	2	2	1	2	2	3
15	1	2	5	2	2	3	4	1	2	1	2	1	0.5	0.5	1	0.5	2
16	1	3	3	2	3	2	4	1	2	3	2	2	2	0.5	2	1	2
17	0.3	1	3	1	1	1	3	0.5	1	1	1	0.5	0.5	0.3	0.5	0.5	1

μmax = 17.6989, *n*=17, CR=0.027

Criterion map: 1) Slope-Aspect, 2) Elevation, 3) Geology, 4) Soil type, 5) Climate type, 6) Precipitation 7) Humidity, 8) Temperature, 9) Sunshine, 10) Distance to river, 11) Distance to electrical grid, 12) Distance to cities 13) Distance to roads 14) LULC, 15) Population density ratio, 16) Employment rate, and 17) Population growth rate.

Table 5-9 The weights of criteria and scores of the sub-criteria

Main criteria	Weights	Influence (%)	Sub-criteria	Score
Aspect-Slope	0.11	11%	N, E, S,W (≤10%), Flat	9
			N (10−15%)	5
			N (15−20%)	4
			N (20−25%)	3
			N (25−30%)	1
			S (10−15%)	8
			S (15−20%)	7
			S (20−25%)	6
			S (25−30%)	4
			E (10−15%)	5
			E (15−20%)	4
			E (20−25%)	3
			E (25−30%)	1
			W (10−15%)	8
			W (15−20%)	7
			W (20−25%)	6
			W (25−30%)	4
			N, E, S,W (≥30%)	Restricted
Elevation	0.04	4%	-80−0	9
			0−500	8
			500−1,000	7
			1,000−2,000	3
			2,000−4,000	1
			>4,000	Restricted
Geology	0.03	3%	Cenozonic	9
			Mesozoic	7
			Paleozonic	5
			Proterozonic	5
			Proterozonic-Paleozonic	3
Soil type	0.06	6%	Alfisols	9
			Inceptisols	7
			Mollisols	5
			Costal sands	Restricted
			Rock Outcrops-Entisols	1

Main criteria	Weights	Influence (%)	Sub-criteria	Score
			Rock Outcrops- Inceptisols Salt Flats Water body	 1 Restricted Restricted
Climate type	0.04	4%	Semi-Arid Mediterranean Semi-Humid Humid Very Humid	1 3 5 7 9
Precipitation	0.05	5%	26−42 mm 43−53 mm 54−64 mm 65−83 mm 84−110 mm	1 3 5 7 9
Humidity	0.02	2%	55−60% 60−65% 65−70% 70−75% 75−80%	1 3 5 7 9
Temperature	0.07	7%	10−12 12−14 14−16 16−18 18−20	1 3 5 7 9
Sunshine	0.05	5%	1,565−1822 hours 1822−2079 hours 2079−2336 hours 2336−2593 hours 2593−2,850 hours	3 5 7 8 9
Distance to river	0.05	5%	0−1 Km 1−2 Km 2−3 Km 3−4 Km > 4 Km	9 7 5 3 1
Distance to electrical grids	0.05	5%	0−10 Km 10−20 Km 20−30 Km 30−40 Km 40−50 Km	9 7 5 3 1

Main criteria	Weights	Influence (%)	Sub-criteria	Score
Distance to cities	0.06	6%	0−10 Km 10−20 Km 20−30 Km 30−40 Km >40 Km	1 3 5 7 9
Distance to roads	0.06	6%	0−10 Km 10−20 Km 20−30 Km 30−40 Km	9 7 5 3
LULC	0.11	11%	Low Forest, Moderate Forest, Dense Forest Urban settlements Range Rock Agriculture and Farming Shoreline Wetland	 1 Restricted 5 Restricted 9 Restricted Restricted
Population density rate	0.07	7%	0−200 200−400 400−600 600−800 800−1000	9 7 5 5 3
Employment rate	0.08	8%	29−37% 37−44% 44−51% 51−58% 58−66%	9 7 5 3 1
Population growth rate	0.04	4%	-12− 0% 0−6% 6−12% 12−18% 18−22%	9 7 5 4 3

5.4.2 Analysing generated criterion maps

5.4.2.1 Environmental criterion maps

The suitability of land for agricultural purposes have a strong link to slope and aspect (direction of exposure) due to several reasons. First, the thickness of top soil layer, as an important resource for agriculture, reduces with rising slope and vice versa (Akinci et al., 2013). Thus, in several studies, lands with more than 30 percent slope (100 percent = 45 degree) were often selected as non-suitable for agricultural activities (Akinci et al., 2013; Bathrellos et al., 2013; Jones et al., 2014). Second, at high slope gradient, the risk of flooding is increased, whereas development of soil is reduced (Akinci et al., 2013). Third, on development side, the gradient of land has a strange influence on contraction of the basic infrastructures such as road and facilities. Fifth, the aspect of the slope can significantly influence local sun exposure and temperate, whereas both parameters are crucial for maintaining photosynthesis. Generally, in the northern hemisphere, as a result of receiving more sunlight, south-western facing slopes became warmer compared to the north-eastern facing slopes (Måren, Karki, Prajapati, Yadav, & Shrestha, 2015). According to the computed Aspect-Slope map (see Figure 5-10), around 20.63 percent of the study area was distinguished as the flat and gently slope area (N, E, S, W $\leq$10%), while around 53.25 percent of the Mazandran province was identified as very steep area with above 30 percent slope (Appendix 7). This very steep area was considered as the restricted area in this assessment due to number of reasons. First, in several studies, lands with the slope above 30 percent were considered above as not-suitable slope class for agricultural activities (Akinci et al., 2013; Jones et al., 2014; The State of New South Wales, 2002). Second, we assumed that the costs of required basic infrastructure for rural development including access road will increase in very steep land. However, it should be noted that these lands are currently considered as non-suitable for farming activities, while it is possible

to do some slope modification to prepare the land such as trace farming technique. In addition, it should be noted that the slope modification required some efforts including labor force, machinery, and financial resources. Table 5-10 summaries the reported topographic constrains for agricultural purposes.

Table 5-10 Applied non-suitability topographic factors in literature for agricultural activity

Factor	Applied classes	Reference
Elevation (m) Slope (%) Aspect	Above 3,600 Above 30 % NE and NW	(Gaden et al., 2015)
Elevation (m) Slope (%)	Above 2,000 Above 40 %	(Widiatmaka et al., 2016)
Slope (%)	Above 25 %	(Elsheikh et al., 2013)
Elevation (m) Slope (%) Aspect	Above 2,100 Above 30 % N	(Akinci et al., 2013)
Elevation (m) Slope (%)	Above 1,600 Above 20%	(Bathrellos et al., 2013)

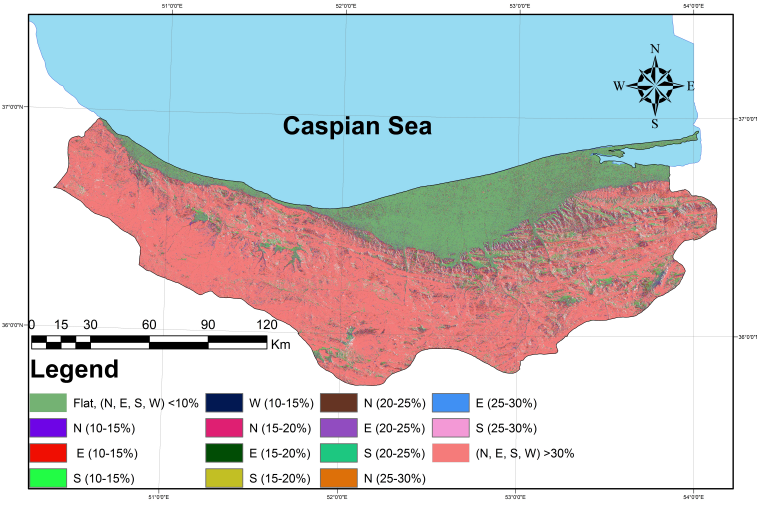

Figure 5-10 Computed Aspect-Slope map of the study area

The derived map elevation of the region ,as represents in Figure 5-11, shows that the majority (69.11 percent) of lands are located fewer than 2,000 meter above the see level, while the highest level (i.e. Mount Damavand), is about 5,602 meter above the see level. In this study, the land category of above 4,000 meter (about 0.37 percent of the total study area) was considered as non-suitable for agricultural activities, whereas several studies were also applied the limitations for elevation level in LSA assessment (see Table 5-10).

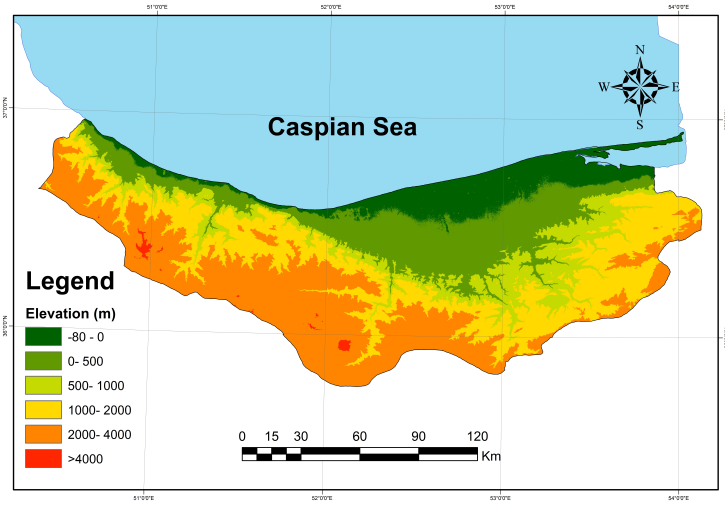

Figure 5-11 Extracted elevation level map of the province of Madandaran

The generated climatology maps of study area are present as precipitation (Figure 5-12), relative humidity (Figure 5-13), annual temperature (Figure 5-14), sunshine hours (Figure 5-16), and climate type (Figure 5-15) maps. According to the calculated climate type (based on the extracted records for the period of 2006−2014) approximately 46.65 percent of the study area is recognized as semi-humid climate type, while 2.49 of the region is located in semi-arid climate type. The annual precipitation range also indicates that the region was received between 312−1,320 mm rainfall per year as the mean annual precipitation rate. In addition, the majority of the study area is identified as the class types of 504−636 mm and 636−768 mm with an aerial percentage of 41.43% and 40.04%, respectively. The obtained mean precipitation rate also shows that about 3.79 percent of the total study area collected less than 504 mm of rainfall for the period of 2006−2014. In the present study, a group of crops (e.g. olive, barley, potato, wheat, watermelon, corn, and cotton) were selected to

establish an estimation for water demand in farming, whereas above 500 mm rainfall per year rate is considered as a suitable rate for the selected crops (see Appendix 6). Thus, the precipitation rate was not considered as the limiting condition for farming practice under the rainfed condition. The rainfed farming type was selected in this study in order to avoid the irrigation installation costs. However, the availability of water depends on several factors such as humidity, vegetation cover, evapotranspiration, and climate type. The generated relative humidity rate map illustrates that the major part of the study area has the humidity above 65% rate, while approximately 4.45 percent of lands have the relative humidity rate of 55−60 percent for the period 2006−2014.

The calculated average annual temperature and sunshine maps (for the period of 2006−2014) indicate that region have approximately the average temperature between 10−20 degree of Celsius, while the majority of area (76.29%) is located between two sub-classes of 12−14 ℃ and 14−16 ℃. In addition, the majority of study area are exposed to around 1,822−2,336 hours of sun per year, whereas 5.32 percent of the study area is classified as bellow than 1822 hours per year in the cumulative annual sunshine rate. Besides, the entire region has a good access to rivers, whereas the largest distance to river is less than 4 Km. In addition, the majority of lands (54.02 %) are located in the less than 1 Km distance of a river.

In general, three main trends can be detected from the obtained climatological maps (based the period of 2006−2014 records): 1) the lands that are closer to the Caspian Sea have a higher temperature and precipitation rates, 2) the western part of study area is more humid compared to the eastern part, and 3) solar radiation is lower at the closer area to the Caspian Sea.

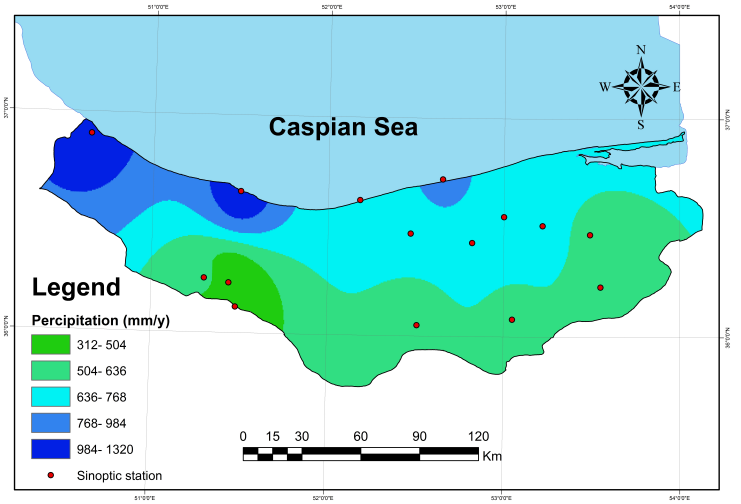

Figure 5-12 Generated precipitation map

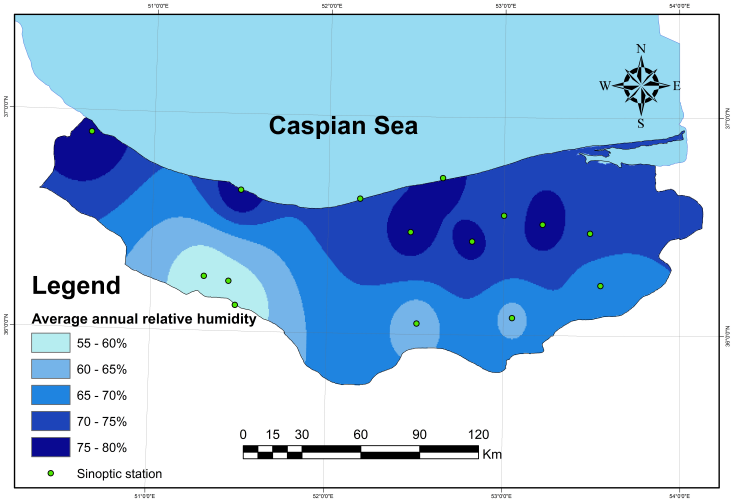

Figure 5-13 Generated average annual relative humidity map

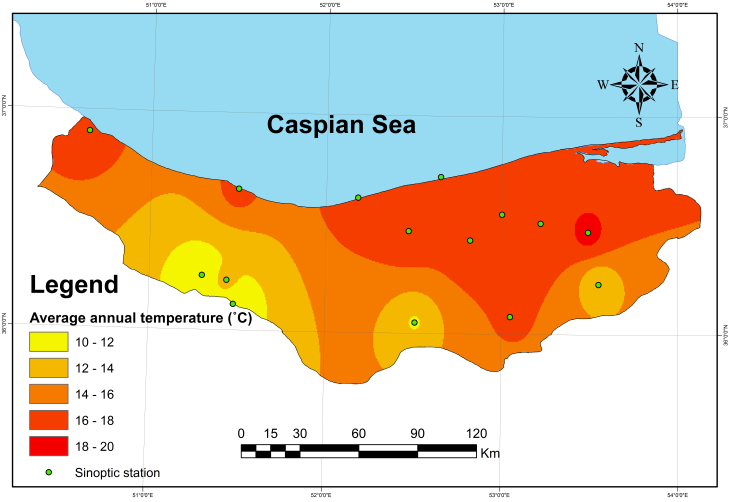

Figure 5-14 Generated average annual temperature map

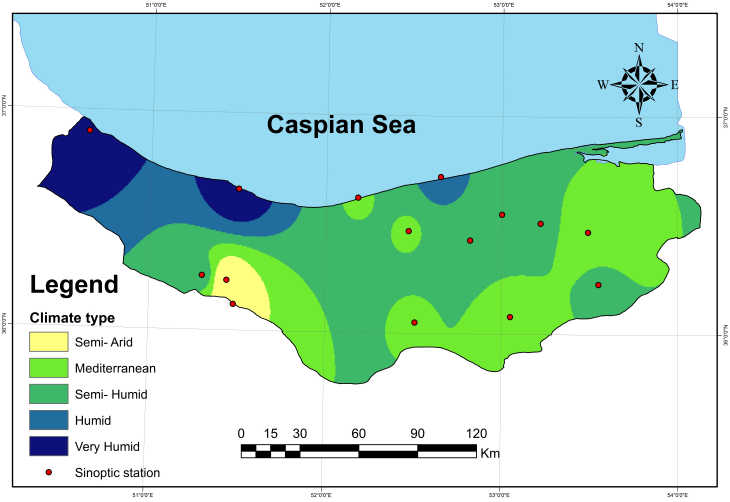

Figure 5-15 Generated climatology map

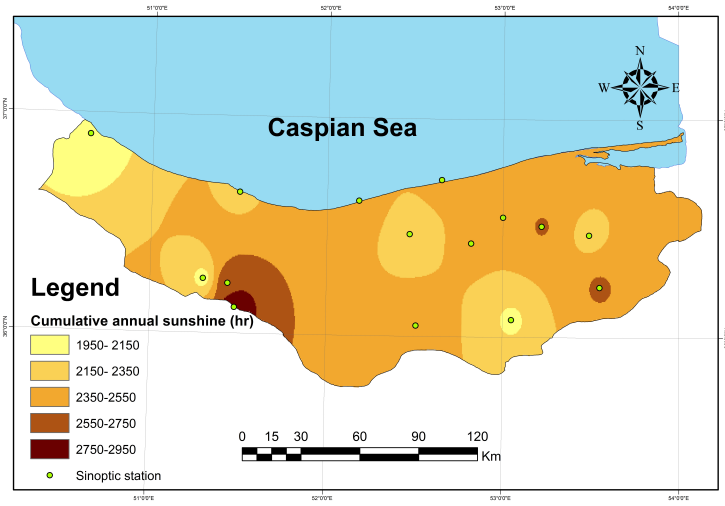

Figure 5-16 Generated cumulative annual sunshine map

5.4.2.2 Socio-economic criterion maps

According to the calculated distance to the electrical grid map (see Figure 5-17), around 62.30 percent of the entire region has less than 10 Km distance to electrical grids, while approximately 5.06 percent of lands have more than 30 Km distance to the main grids. This relatively close distance to the electrical grid is related to the distribution of city and rural points in the study area, whereas the majority of lands are located in less than 20 Km distance to city area. The calculated distance to city map, presented in Figure 5-18, also shows that only about 3.02 percent of the total lands are placed with more than 30 Km distance to urban settlements.

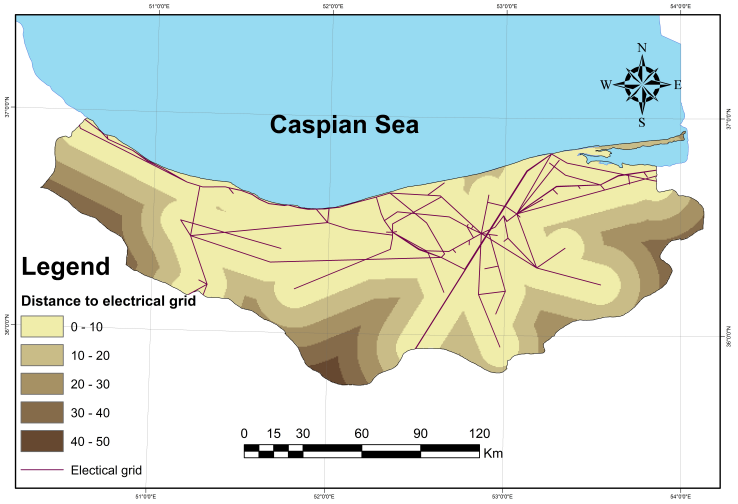

Figure 5-17 Generated distance to electrical grid map

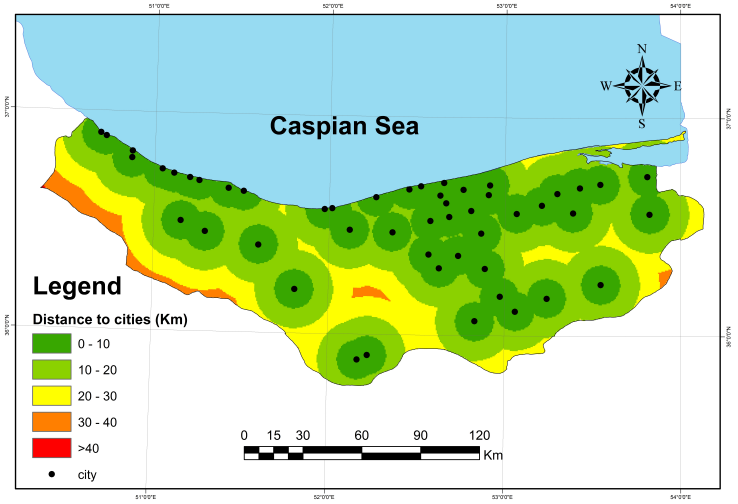

Figure 5-18 Generated distance to cities map

The extracted employment rate map (see Figure 5-19) illustrates that the majority of areas (90.43 percent) in the study area are identified as very low rural employment area with an employment ratio below 44%, while the maximum rural employment rate ratio is about 66%. This low employment rate also may have a strong link to the generated population growth map of rural settlements for a period of 2006−2011, whereas around 42.33 percent of lands are identified as depopulated rural areas (with a ratio between -12−0 percent). The majority of counties (81.1%) have a population density rate (calculated for both rural and city points) below than 100 persons per square kilometer, while about 17.74% of lands are identified as very low populated area with the population density rate of less than 5 persons per square kilometer. Although, approximately 12.16% and 6.74 % of the total areas are classified as high to very high populated area with the population density rate of 100−200 and 200−1,000 persons per square Km, respectively.

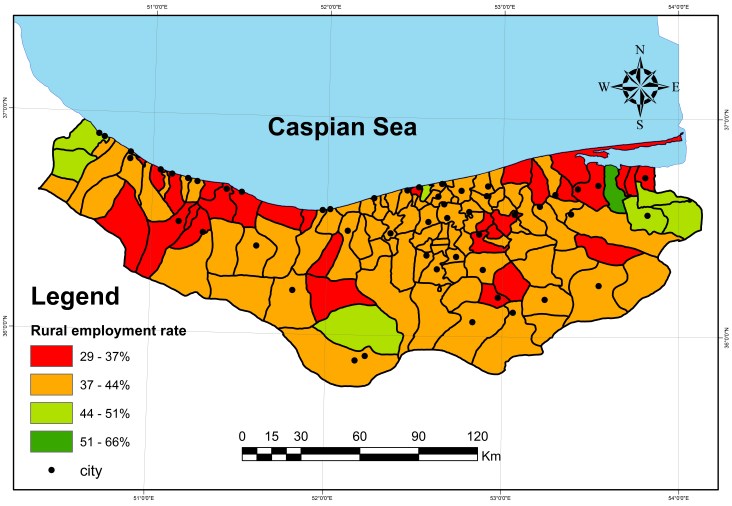

Figure 5-19 Generated rural employment rate map

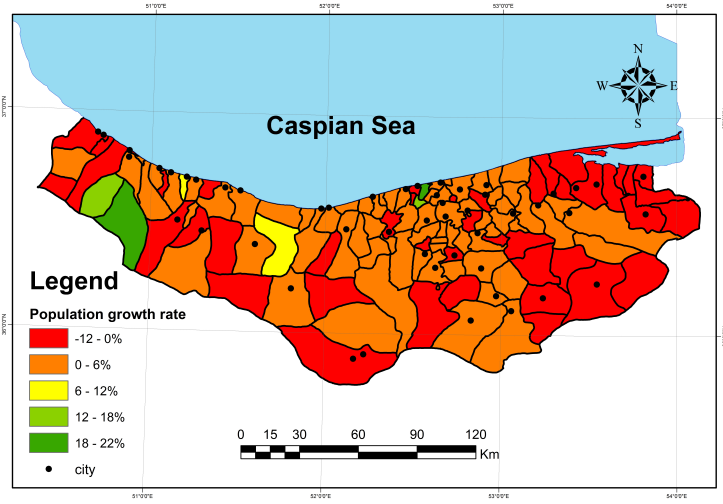

Figure 5-20 Generated rural population growth rate map

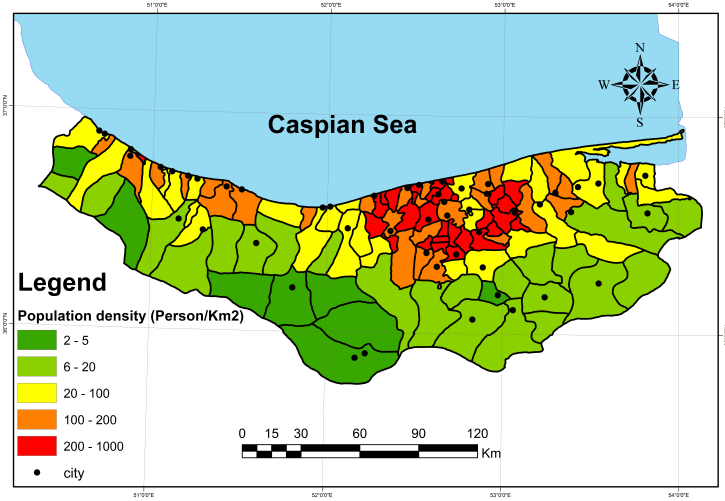

Figure 5-21 Generated population density map

5.4.2.3 Land suitability map

According to the calculated land suitability map (see Figure 5-22), it was determined that 163.29 Km^2 (0.68% of the total area) is highly suitable for *New Town* development purpose. While 2,418.79 Km^2 (10.15 %) is moderately suitable, 2,749.06 Km^2 (11.53 %) is marginally suitable land, 1,931.86 Km^2 (8.10 %) is currently not suitable, 28.38 Km^2 (0.12%) is permanently unsuitable. In addition, 11,157.59 Km^2 (46.80 %) is identified as technically restricted area (e.g. as water bodies, elevation level above 4,000 meter, costal area, urban settlements) and 5,392.32 Km^2 (22.62%) is protected area (i.e. national park, wildlife refuge, and natural protected area). Among the considered restrictions, high slope (30−500 degree) is noted as one of the important topographical limitation, whereas approximately 53.25% of total area was classified as very steep area (Appendix 7).

Considering the LULC map (see Appendix 5), about 23.43% of the study area is used for agriculture, while forest and ranges cover approximately 45.17% and 28.47% of the total study area. The obtained suitability results indicate that about 99.21% (162.01 Km^2) of the highly suitable lands, 82.74% of the moderately suitable lands (2,274.70 Km^2), and 20.29% of the marginally suitable lands (557.70 Km^2) were located in the agriculture land use type.

In general, considering the aforementioned limitations, the calculated result for LSA assessment shows that only 0.68% of the whole study area was recognized as the highly suitable for organic farming and rural development. Comparably, results of a conducted LSA study in hilly areas of Ispir (with 89.68% of total area as slope range above than 30%), Erzurum (Turkey), show than only 0.4 % of total area is more suitable for doing agricultural activity (Akinci et al., 2013). In another study in Darjeeling District (with 49% of total area as the slope rage between 30−89%), West Bengal (India), only around 5.31 % was reported as the most suitable sites for agricultural land use (Pramanik, 2016).

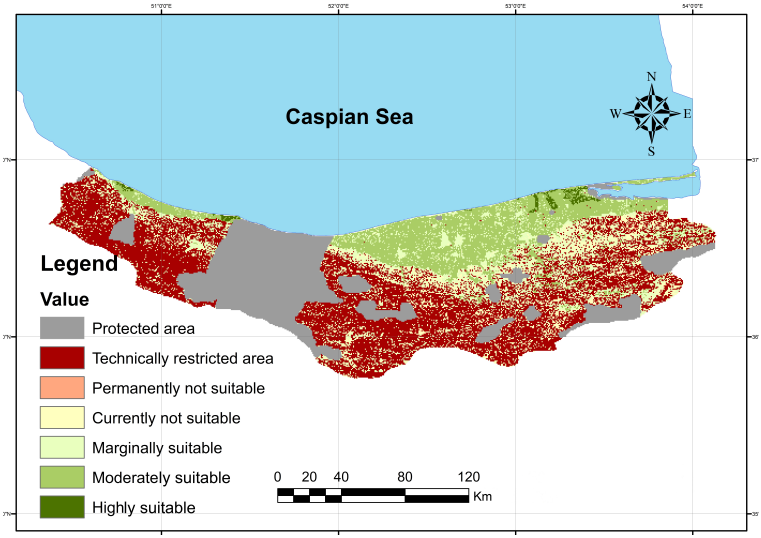

Figure 5-22 Calculated suitability map

5.4.3 Analysing visualization results

To check the balance of decision support model, the distribution of existing farming lands among the suitability classes was determined through observation with high resolution Google Earth images. Since the study area is relatively big and the imaginary technique is an extensive operational process, we decided to randomly examine about 2,400 square kilometer, which is approximately 10 percent of the total study area. This randomly selection in imaginary observation was applied in other LSA studies (Mesgaran et al., 2017). As it was explained in Section 5.3.17.1, both calculated suitability map and Google Earth images were overlaid together in Google Earth, as shown in Figure 5-23, and the percentage of existing agricultural lands in each cell was observed.

Figure 5-23 An example of high resolution Google Earth images used in visualization step

The obtained visualization observation results, as presented in Figure 5-24, show that approximately 94 percent of highly suitable, 78 percent of moderately suitable, and 16 percent of marginally suitable lands were used for agricultural activities in the randomly selected areas. Moreover, less than 10 percent of lands in other suitability classes were identified as farming lands. This observed results also indicate that the proposed decision support LSA model is reliable among highly suitable, moderately suitable, and marginally suitable classes. However, around 10 percent of agricultural activities among the other suitability classes was detected. In the technically restricted area around 5 percent of lands were detected as farming land. This observed farming land may have a link to slope and aspect in the study area, whereas we considered a limitation in slope-aspect criteria and slope farming practice was not the main focus for this study.

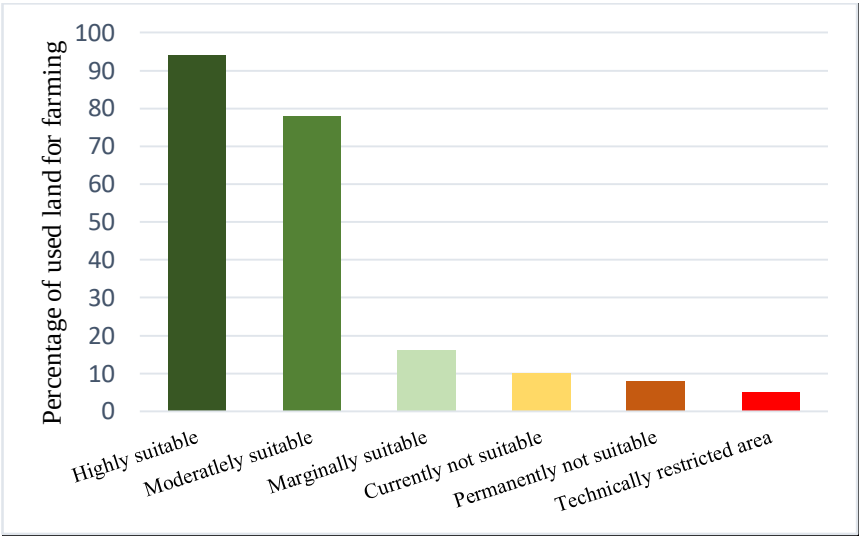

Figure 5-24 Distribution of Mazandaran province's existing farming lands among different suitability classes (based on a visualization observation)

5.4.4 Selection of highly suitable county

The LSA results were extracted for the top ranked counties, as presented in Table 5-11, whereas 86.80% of highly suitable lands (141.73 Km^2), 14.07% of moderately suitable lands (340.47 Km^2), and 3.02% of marginally suitable lands (88.14 Km^2) are located in these counties. At a county level, Miankaleh, Miyandorodbozorgh, Roodpayshomali, Kalarastaghgharbi, and Golijan counties were determined as the most suitable places for *New Town* development with 66.90 Km^2, 24.33 Km^2, 23.22 Km^2, 15.85 Km^2, and 11.43 Km^2, respectively. Thus, the Miankaleh County was selected as the top ranked county location for the rest of this study.

Table 5-11 Areal distribution of agricultural land suitability analysis results for selected counties in the Mazandaran province of Iran

Suitability classes (Km^2)	County Name				
	Miankaleh	Miyandoro dbozorgh	Roodpays homali	Kalarastag hgharbi	Golijan
Highly suitable	66.9	24.33	23.22	15.85	11.43
Moderately suitable	206.29	29.49	44.6	14.01	46.08
Marginally suitable	6.69	-	1.47	17.32	62.66
Currently not suitable	-	-	-	-	13.64
Permanently not suitable	-	-	-	-	-
Restricted areas	19.7	95.47	85.52	-	-
Protected areas	58.36	6.63	-	24.7	250.65
Total Area	357.94	155.92	154.81	71.88	384.46

5.4.5 Analyzing the highly suitable county

All selected criterion maps were extracted for the Miankaleh County and the results are presented in Table 5-12. According to the extracted hypsometry data, the majority of lands (74.14%) in this county are classified as flat with very low slope gradient (less than 10%), which is associated with relatively low elevation level from the sea level. The selected county has a rich fauna and flora, whereas one of the UNESCO Biosphere Reserve is located at the western part of this area as the Miankaleh wetland. This wetland has a shallow marine water, with a sandy shore, whereas several species have observed in this wetland such as the White-tailed Eagle (*Haliaeetus albicilla*), Dalmatian Pelican (*Pelecanus crispus*) and the White-headed Duck (*Oxyura leucocephala*) (UNESCO, 2015). This wetland has a great value as a wintering station to many unique Caspian birds and more than 250,000 migratory birds (recorded for the year 2010). During the field survey, beginning of December 2017, a group of migratory

flamingo was also observed in the Miankaleh wetland (Figure 5-25). Since this wetland has only one connection with the Caspian Sea, the observed decreasing level change trend in the Caspian Sea has affected the ecological sustainability in the region (Beni et al., 2013; National Research Centre of Caspian Sea of Iran, 2014).

Figure 5-25 Observed migratory flamingo birds in the Miankaleh wetland (beginning of December 2017)

At the northern part of the Miankaleh wetland, the Miankaleh peninsula is located (see Figure 5-26). This peninsula is around 48 kilometers long and between 1 to 3 kilometres wide. The land cover of this area consists of forested peat lands, raspberry shrub forests, and Tamarix forests. According to the Department of Environment of Iran, all building materials in the Miankaleh wild life refuge area should be provided from the local ecological friendly resources. While, a village with few locals was located in this peninsula. The human activities in this peninsula are considered as animal husbandry, fishing, and ecological tourism (mainly for birds' watchers). About 23 livestock farms and 25 cooperative fishing companies were reported in this area for the year 2010 (Adeli, 2013).

Figure 5-26 An example of landscape cover in the Miankaleh peninsula (beginning of December, 2017)

The climate type in this county is identified as semi-humid, where about 10% of the total county is classified as the Mediterranean climate type. According to the land use-land cover map, around 47.46% (150.65 Km2) of this area is under agricultural and farming practices.

On socio-economic side, the local people mainly were reported from four ethnic origins as: Turkmen, Kurd, Turk, and Mazani (UNESCO, 2015). The Miankaleh County has a negative rural population growth rate that is associated with a relatively low employment rate (29-37%) among the rustic settlements. In addition, the population density rate of this area is between 20−100 persons per square kilometre.

Table 5-12 Characteristic of the Miankaleh County

Main criteria	Sub Criteria	Area (Km2)	Area (%)
Aspect-Slope	N, E, S,W (≤10%), Flat	263.22	74.15
	N (10−15%)	19.16	5.40
	N (15−20%)	7.10	2.00
	N (20−25%)	2.23	0.63
	N (25−30%)	0.76	0.21
	S (10−15%)	19.76	5.57
	S (15−20%)	7.12	2.01
	S (20−25%)	2.20	0.62
	S (25−30%)	0.67	0.19
	E (10−15%)	10.67	3.01
	E (15−20%)	3.58	1.01
	E (20−25%)	1.16	0.33
	E (25−30%)	0.40	0.11
	W (10−15%)	10.47	2.95
	W (15−20%)	3.39	0.96
	W (20−25%)	1.09	0.31
	W (25−30%)	0.41	0.12
	N, E, S, W (≥30%)	1.58	0.45
Elevation (m)	-80−0	354.58	99.89
	0−500	0.39	0.11
Geology	Cenozonic	354.97	100
Soil Type	Mollisols	178.55	50.30
	Costal sands	140.29	39.52
	Salt Flats	36.13	10.18
Climate type	Mediterranean	44.72	12.60
	Semi-Humid	310.25	87.40
Precipitation (annual & accumulative)	648−768 mm	-	-
Humidity (Average annual relative)	70−75%	-	-
Temperature (Average annual)	16−18 (°C)	-	-
Sunshine (Cumulative annual)	2,350−2,550 hours	-	-
Distance to river	0−1 Km	233.11	65.67
	1−2 Km	111.51	31.41
	2−3 Km	10.35	2.92
Distance to electrical grid	0−10 Km	257.87	72.65
	10−20 Km	89.41	25.19
	20−30 Km	7.69	2.17

Main criteria	Sub Criteria	Area (Km2)	Area (%)
Distance to cities	0−10 Km 10−20 Km 20−30 Km 30−40 Km	71.18 239.92 43.57 0.31	20.05 67.59 12.27 0.09
Distance to roads (main roads)	0−10 Km 10−20 Km 20−30 Km	225.81 113.21 15.95	63.61 31.89 4.49
LULC	Urban settlements Range Agriculture and Farming Wetland	2.92 150.65 168.45 32.95	0.82 42.44 47.46 9.28
Population density rate	20−100 (persons/Km^2)	-	-
Employment rate	29−37%	-	-
Population growth rate	-12− 0%	-	-

The Miankaleh County has a good logistic access due to a number of reasons. First, the Sari International Airport is located about 20 Km far from this county (see Figure 5-27). This airport has two terminals (i.e. a domestic & an international terminal) with approximately 18,000 square meters footprint size. The extracted records shows that 3,154 domestic and International flights were conducted in this international airport for the year 2016 (Iran Airports & Air Navigation Company, 2016). Second, the selected county has a good connection to the railways network (Appendix 5). As an example of this access, three train stations are located about less than 10 Km far from the Miankaleh county that can be used by locals (see Figure 5-27).

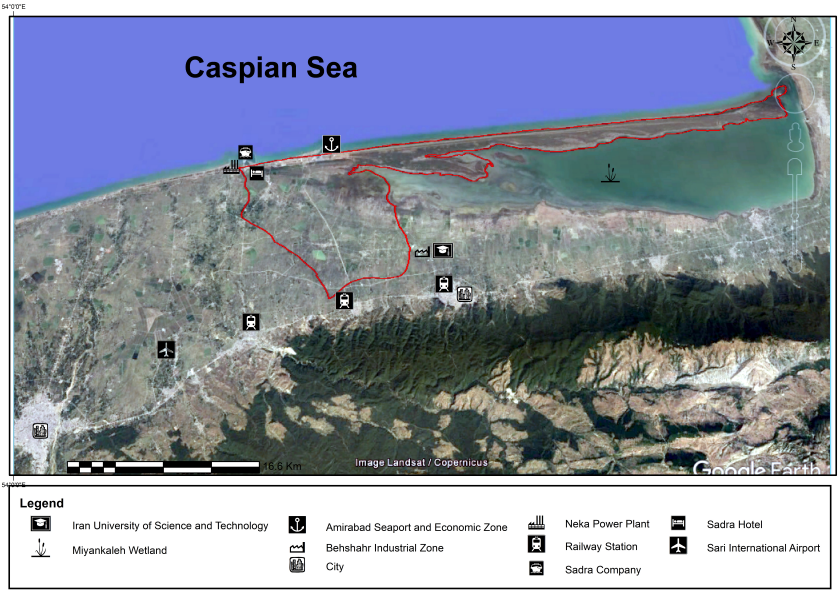

Figure 5-27 Available infrastructures in the Miankaleh county (Extracted from Google Earth, 2017)

Behsharh Industrial Zone is located about 2 Km far from the Miankaleh county. This Industrial zone has about 2 square kilometer footprint with about 49 small-scale manufacturing company from different fields including pulp and paper, food and beverage (e.g. Rapeseed oil processing facility), dairy and chemical industries (extracted from Iran small industries and Industrial Park Organization, 2017). In addition, the closest city (i.e. Behshahr city) has around 80,000 population that can be noted as the closest urban market for organic farming products.

Amirabad Port and Free Trading Zone are sited at the northern part of the Miankaleh County (see Figure 5-27). The Amirabad Port is acknowledged as one the major Iranian seaport with an approximate annual capacity of 7.5 million tons (Amirabad port, 2018). In addition to this operational capacity, this port has a connection to the railways network. Besides, several manufacturing sites are located in the

Amirabad Free Trading Zone including a steel company, a gypsum manufacture, an oil treatment plant, and a pulp and paper factory. Recently, a facility for converting non edible wheat to bio-ethanol is under construction in this economic zone. In addition to the aforementioned sites, SADRA (Iran Marine Industrial Company) has a branch in the selected county (see Figure 5-27), this company is involved in several business activities such as: offshore technologies for oil and gas development, docks and floating oil rigs, and building cargo ships. More recently, SADRA has also started hospitality business as well. As an example to this hospitality business platform, SADRA Hotel (4 Star Hotel) is located in the Miankaleh County. This hotel has 100 rooms, 12 suites, 6 villas and one penthouse apartment with an approximately 8,300 square meters footprint size.

Neka Thermal Power Plant is placed at the northern part of Miankaleh County. This power plant has an operational capacity of 2,213 Megawatt per hour with 6 units (four thermal units, and two oil-gas units). Several oil and gas storages facilities were build close to this power plant for supplying the required fuels. The exhaust gas from this facility can be considered as an air pollution source in the study area, whereas the average concentrations of NO, NO_2, CO, and H_2S were reported above the standard level as 0.4 ppm, 0.3 ppm, 2.4 ppm, and 0.2 ppm respectively (Asadi, M., Najafpour, G.D., Mehdizadeh, 2010). These results were detected at a distance range of 5−10 Km from the Neka Power Plant. Therefore, a shift from fossil fuel to green energy production is highly required for the Miankaleh County in order to conserve the environment. This quest is well understood by the policy makers in the Mazandaran province of Iran, whereas several positive steps have been taken to support renewable energy applications in residential and commercial buildings. As an example of this support, 50 percent of the total costs of solar panel installation in building is been paid by the government. In spite of this supportive policy, only 5 villages in the Mazandaran province have installed small-scale renewable facilities (Extracted from Renewable Energy and Energy Efficiency Organization of Iran, 2017). Besides, further

long term studies are required to evaluate the impacts of exhaust gas from the Neka Power Plant on farming and surrounding environment. The Miankaleh County has a good access to higher educational facilities, whereas the Iran University of Science and Technology has a small campus (i.e. with about 800 students) nearby the Miankaleh County (see Figure 5-27). Several majors are available at this campus including software engineering, industrial and process engineering, electrical engineering, and applied mathematics. This campus also has small sport facilities such as a football court and a sport center that can be used by public sectors. Other higher educational facilities can be found in nearby cities.

From economic point of view, the cost of land was not included in this research because there is no available data sets for that. However, during the field study period, we asked form locals about the land cost in Miyankaleh County, according to them and about 2-6 UD dollars per square meters can be considered as a rough estimate for land value in this area.

5.5 Summery

The aim of this study was primarily focused on the identification of the suitable land for creating *New Town* settlements in the Mazandran province of Iran. The analytic hierarchy process with integration of GIS was established for LSA study in which several socio-economic criteria were selected. At the end of assessment, it was computed that only 0.68 % (163.29 Km^2) is highly suitable and 0.12% (28.38 Km^2) is permanently unsuitable. Besides, around 53.25% (12,694.31Km^2) of the study area was evaluated as very high slope (above 30 percent gradient), which was classified as technically restricted category.

The validation of proposed decision support LSA model was conducted by a visualization step, whereas around 10 percent of lands (about 2400 Km^2) in study area randomly were selected for this analysis. The observation results indicated that approximately 94

percent of highly suitable, 78 percent of moderately suitable, and 16 percent of marginally suitable lands were used for agricultural activities. Further validation step was taken by a field study analysis in the top ranked county. According to LSA results, among 119 counties in the study area, the Miankaleh County was identified as high potential site for *New Town* development, whereas about 66.90 Km^2 of highly suitable lands were located in this county. This county has a unique environmental quality with a rich fauna and flora. Besides, topography evaluation indicated that this county has relatively smooth slope gradient that is associated with semi-humid climate type. Form socio-economic analysis, this county has an imbalanced urban-rural growth, whereas a negative growth rate for rural settlements was detected. Besides, low employment rate (22−37%) can be noted as another socio-economic challenge for this county. Although, several opportunities such as unique environmental quality, close distance to the Caspian Sea, and a good logistic access can be considered for creating *New Town* settlements.

Chapter 6 Conclusion and outlook

6.1 Summary of main research findings

In the research described in this dissertation a variety of approaches have been used to answer some of challenging questions for balancing urban-rural growth in the Mazandaran province of Iran by *New Town* planning concept with respect to the socio-economic-environmental structures in the study area. Some of the main findings of this study can be listed as below.

- In **Chapter 3**, analysing of small-scale enterprises shows that small-scale business can be profitable and this profitability has a link to management skill rather than size of business. Direct marketing strategy and capturing more added value in the business platform was identified as one of the key success along with application of low-tech solutions. In all studied cases a positive influence between successes of business with social development was detected in different domains of life that associated with several achievements in maintaining environmental quality.

- In **Chapter 4**, the conducted well-being assessment shows that the surveyed locals in the Kandelous village of Mazandran province are happy and satisfied from their life. The economic structure analysis in the villages showed that Agro-industrial sector plays an important role in the economic structure. Besides, the high rate of employment also was detected, while the majority of surveyed people (95.5 percent) are satisfied from their job at a scale of medium to very strong. Moreover, we captured a high rate of satisfaction with health status, environmental quality (soil, water, air), personal security, and together with a high contribution with local government. Our

findings indicate that it is not only income level that determine how much people are satisfied from their life, whereas several socio-economic factors are involved. Thus, the selected village was identified as a good place to life according to the judgements of local people about their life.

- In **Chapter 5**, the established AHP-GIS decision support model show that 163.29 Km^2 (0.68% of the total area) is highly suitable for *New Town* development purpose. While 2,418.79 Km^2 (10.15 %) is moderately suitable, 2,749.06 Km^2 (11.53 %) is marginally suitable land, 1,931.86 Km^2 (8.10 %) is currently not suitable, 28.38 Km^2 (0.12%) is permanently unsuitable. At the county level, the Miankaleh County was identified as highest potential place for *New Town* development, where about 66.90 Km^2 of highly suitable lands are located in this county. The applied validation steps showed that the obtained results are valid and this county has a unique environmental quality with a rich fauna and flora. However, several socio-economic challenges were identified in this county such as low rural employment rate and a depopulation tendency in rural settlement. Although, several potentials can be used for balancing urban-rural growth in this county such as availability of water, suitable topographic condition, close distance to the Caspian Sea, and along with a good logistic access.

6.2 Outlook

This study was based on selected aspects and parameters in the context of sustainability and for the case study area. Therefore, it is recommended to verify the findings of this study with further investigation for application in other regions. Moreover, further research work is recommended as listed below.

- Establishment of human well-being GIS databases are highly recommended for both urban-rural settlements. These databases can be used for different purposes such as *New Town* planning. In addition, governments also can use these data to provide a better life for people. At the moment, only national reports for some aspects are available in some countries but these reports emphasis on national level with ignoring the differences that exist between city and rural life.

- Evaluation of human well-being assessment among different age brackets (such as children) and genders are recommended for urban-rural settlement to highlight the differences that exist between the aforementioned groups.

- For project application in the study area, detail data collection and assessment are recommended at a project scale.

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Appendix 1 Name of counties in the Mazandaran province of Iran

No.	Name of County	No.	Name of County	No.	Name of County
1	Sakhtsar	27	Miyandoroodkochak	53	Daboyjonobi
2	Chehehshahid	28	Barikroodshomali	54	Fiziyeh
3	Golijan	29	Dohezar	55	Natelkenarsofla
4	Gharehtoghan	30	Ashkor	56	Karipay
5	Miyandorrodboz orgh	31	Pazvar	57	Baladehkajoor
6	Rodpayshomali	32	Emamzadehabdolah	58	Asfiroodshorab
7	Kohestan	33	Siyahrood	59	Kelardashtgharbi
8	Panjhezar	34	Kalarastaghgharbi	60	Nokandkola
9	Golpadgharbi	35	Daboyshomali	61	Talarpay
10	Janatroodbar	36	Kelarastaghsharghi	62	Tatelkenaralya
11	Golpadsharghi	37	Hasanzadeh	63	Miyanband
12	Azadeghan	38	Ashrestagh	64	Hezarpayjonobi
13	Baladeh	39	Sehezar	65	Kalej
14	Mirshamsodin	40	Khoshkrood	66	Natelrastagh
15	Larim	41	Hezarpayshomali	67	Bironbesham
16	Ketra	42	Shohada	68	Kalijanrostaghsofl a
17	Chaprood	43	Payrajeh	69	Miyanrood
18	Mehravan	44	Khirood	70	Paieinkhiyabanlati koh
19	Tamashkol	45	Mazkoreh	71	Tavabekajoor
20	Behnamir	46	Hezarpaygarbi	72	Janghafrooz
21	Toskacheshmeh	47	Azizak	73	Bishehsara
22	Langeroodshargh i	48	Kilakala	74	Lalehabad
23	Saheli	49	Ahmarestaghjonobi	75	Asbokola
24	Rodbarjonobi	50	Kohdasht	76	Panjakrastagh
25	Babolrood	51	Zamrood	77	Balatajan
26	Kelarabadshrghi	52	Ahmarestaghshomali	78	Aliabad

No.	Name of County	No.	Name of County
79	Kilajanrastagholya	105	Farim
80	Estakhrposht	106	Sorkhkala
81	Dashtsar	107	Firoozjah
82	Kohestan	108	Rastopay
83	Zaboosrastagh	109	Valopay
84	Lavij	110	Larijansofla
85	Kohestan	111	Bonaft
86	Balakhibanlitkoh	112	Balalarijan
87	Jatabshomali	113	Barikroodjonobi
88	Shahidabad	114	Emamzadehabdolahjonobi
89	Tanjehsolyman	115	Langheroodgharbi
90	Gharmaneh	116	Kelarabadgharbi
91	Gatabjonobi	117	Dashtsofla
92	Poshtkoh	118	Kelardashtsharghi
93	Babolkenar	119	Miyankaleh
94	Koshrood		
95	Sharghogharbshirghah		
96	Sajadrood		
97	Chehardangeh		
98	Chelav		
99	Kalisan		
100	Derazkol		
101	Shikfazlolahnori		
102	Lafoor		
103	Tatarastagh		
104	Ozrood		

Appendix 2 Monthly average temperature records in synoptic stations

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
Nowshahr	2006	6.2	8.3	11	14	18	25	25	27	23	21	14	7.8
	2007	7.7	8.5	9.4	13	19	24	25	27	24	19	14	8.9
	2008	3.7	6	13	15	19	23	26	26	24	19	13	8.7
	2009	6.9	9.1	11	11	18	23	26	24	22	19	14	10
	2010	9.8	8.2	9.5	13	19	26	28	27	24	20	14	12
	2011	9	7.7	9	14	19	24	28	25	22	17	10	8.5
	2012	7.8	5.2	7.8	16	22	25	26	27	23	21	15	9.9
	2013	9.1	9.7	11	14	20	24	26	25	24	18	14	8.7
	2014	8.9	6.3	11	14	21	24	26	28	25	17	12	9.7
Golaleh	2006	5.7	10	14	17	21	28	28	30	26	23	15	8.5
	2007	9.1	9.2	11	15	22	26	27	30	27	20	15	9.2
	2008	3.5	7.1	16	18	22	26	28	30	27	20	14	9.5
	2009	7.4	10	14	13	21	26	29	26	25	21	15	11
	2010	10	9.7	12	16	22	29	31	30	26	22	15	13
	2011	9	8	11	16	22	27	31	29	25	19	10	7.9
	2012	7.9	6.1	10	19	25	28	28	30	25	22	16	9.9
	2013	10	10	13	17	23	27	29	27	27	20	16	8.9
	2014	8.9	7	12	17	25	28	29	30	27	19	13	10
Kiyasar	2006	-0.5	7.5	8.6	14	15	21	20	24	18	17	8.2	0.6
	2007	3.4	3.6	4.5	10	17	18	19	22	19	14	9.7	2.8
	2008	-3.9	0.9	13	15	15	17	21	22	20	14	7.4	3.2
	2009	2.2	6.2	8.9	7.8	15	19	21	18	17	14	8.7	5.2
	2010	5.8	5	8.6	11	16	22	23	22	19	16	10	8.5
	2011	2.7	1.5	5.4	13	16	19	23	20	18	13	3.9	4
	2012	2.2	0.3	5	14	18	20	21	23	17	15	9.1	5.2

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2013	4.5	5.6	9.7	11	15	18	20	19	20	13	9.2	2.6
	2014	3.7	1.7	7.4	13	19	20	21	23	20	12	6.7	5.8
Kajor	2006	-	-	9	14	17	22	21	25	19	16	7.2	-0.5
	2007	2	3.2	4.3	11	17	20	20	23	19	14	9.3	2.5
	2008	-5.3	0.6	13	15	17	19	22	23	20	14	6.7	1.9
	2009	0.8	5.5	8.6	8.4	17	19	22	19	17	14	8.1	4.7
	2010	5.5	4.9	9	11	17	24	24	22	20	17	10	8.2
	2011	1.4	1	5.4	13	18	21	24	21	18	12	3	3.4
	2012	1.4	0.6	4.5	14	18	21	21	23	18	15	8.7	4.4
	2013	3.3	5.8	9.2	12	15	19	21	20	21	13	8.4	2.1
	2014	3.1	1.3	7.6	14	19	21	22	24	20	12	5.7	4.9
Gilakala	2006	5	8.4	12	16	19	26	26	28	24	21	14	7.2
	2007	7.2	7.9	9.7	14	20	25	25	28	25	19	14	7.9
	2008	2.9	6.1	14	17	20	23	26	27	25	19	13	8.1
	2009	6.4	9.2	11	12	20	24	27	24	23	19	14	9.9
	2010	9.3	8.8	11	14	21	27	28	28	24	21	14	11
	2011	8.3	7.6	9.5	15	20	25	28	26	23	18	9.3	7
	2012	7.1	5.1	8.4	17	23	25	26	28	23	20	15	9.2
	2013	8.6	9	12	15	21	24	26	25	25	18	14	7.6
	2014	7.8	6	11	16	22	25	27	28	25	17	12	8.9
Siyahbisheh	2006	-2.7	4.4	6.2	11	14	18	17	21	16	14	5.4	-1.8
	2007	1.6	1.5	2.1	9.3	14	16	16	19	17	12	8.1	0.4
	2008	-6.4	-0.7	11	13	14	16	19	20	17	12	4.5	1.3
	2009	0.4	4	7	6.2	14	16	18	16	14	12	6.3	3.7
	2010	5.1	3	7.3	9.2	14	20	21	19	17	15	8	7
	2011	0.5	-0.7	3.7	11	15	17	20	18	15	11	1.7	2.5

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	1.1	-0.7	2.6	11	16	17	18	20	16	13	6.5	3.8
	2013	3.5	4.6	7.5	9.5	12	16	18	17	19	10	6.6	0.9
	2014	1.7	-0.3	5.3	11	16	18	19	22	18	10	4.3	4.2
Sari	2006	5.7	9.3	13	16	20	27	27	29	25	22	14	7.8
	2007	8.1	8.5	10	14	21	25	26	28	25	20	14	8.6
	2008	3.5	6.6	15	18	21	24	27	28	26	19	13	8.8
	2009	7.1	10	13	13	20	25	28	25	23	20	14	11
	2010	10	9.3	11	15	21	28	30	29	25	21	15	13
	2011	8.7	8	10	16	21	25	29	27	24	18	9.7	7.6
	2012	7.8	5.6	8.9	18	24	26	27	29	24	21	15	9.8
	2013	9.6	9.5	13	16	21	25	27	26	25	19	15	8
	2014	8.4	6.6	12	16	23	26	27	29	26	18	12	9.6
Ramsar	2006	6.5	8.5	11	14	18	25	26	28	23	21	14	8.4
	2007	8	8.4	9.3	13	19	24	25	27	25	20	14	9.4
	2008	3.5	6	12	15	19	23	26	27	24	19	14	9.1
	2009	6.9	9.1	11	11	18	23	27	24	23	20	15	11
	2010	9.9	8.3	9.4	13	19	26	28	28	25	21	15	13
	2011	9.2	7.7	8.9	14	19	24	28	26	22	18	10	9
	2012	8.1	5.1	7.8	16	22	25	26	27	23	21	16	10
	2013	9.2	9.8	11	14	20	24	26	25	24	18	14	9
	2014	9	6.3	10	13	21	25	27	28	25	17	12	10
Dashtsari	2006	5.2	8.8	12	16	20	26	26	28	24	21	14	7.4
	2007	7.8	8	9.7	14	21	25	26	28	25	19	14	8
	2008	3	6.1	14	17	20	24	27	28	25	19	13	8.4
	2009	6.5	9.6	12	12	20	25	27	25	23	19	14	10
	2010	9.4	8.9	11	14	21	27	29	28	25	21	14	12
	2011	8	7.6	9.8	15	20	25	29	27	24	18	9.3	7

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	6.9	5	8.5	18	23	26	27	28	24	20	15	9.2
	2013	8.7	9	12	15	21	25	27	26	25	18	15	7.5
	2014	7.8	5.9	11	16	23	26	27	28	26	18	12	8.9
Polsefid	2006	3.7	11	12	16	18	24	23	28	22	20	12	4.6
	2007	8.5	7.3	8.5	13	20	21	22	24	21	18	13	8
	2008	1.6	4.8	17	18	19	21	25	27	23	17	11	7.3
	2009	6.2	11	13	12	18	22	25	21	21	18	12	10
	2010	9.7	8.6	13	14	19	26	27	27	23	19	14	12
	2011	6.8	5.9	8.9	16	19	22	27	24	21	16	7.5	7.1
	2012	6	4.3	8.6	18	22	24	24	27	21	19	13	9.1
	2013	9.4	9	14	15	19	22	24	23	23	17	13	6.2
	2014	7.7	5.7	11	16	22	24	25	28	23	16	10	9.8
Bandaramirabad	2006	5.4	8.8	12	15	20	26	27	29	25	22	14	7.8
	2007	7.8	8.5	9.8	14	20	25	26	28	25	19	14	8.8
	2008	3.2	6.3	13	16	20	24	27	28	26	20	13	8.7
	2009	7	9.5	12	12	20	24	27	25	24	20	14	10
	2010	9.7	8.8	11	14	20	27	29	28	25	21	15	12
	2011	8.6	7.7	9.7	15	20	25	29	27	24	18	9.9	7.7
	2012	7.3	5.1	8.7	16	23	26	27	29	25	21	15	9.5
	2013	9.1	9.8	12	15	21	25	27	26	26	19	15	8.4
	2014	8.3	6.2	11	15	22	26	27	28	26	18	12	9.3
Babolsar	2006	6.3	9.2	12	16	20	27	27	28	24	22	14	8.4
	2007	8.6	8.9	10	14	21	26	26	28	25	20	15	9.5
	2008	4	7.1	14	17	20	24	27	28	26	20	14	9.5
	2009	7.8	10	12	13	20	25	28	25	24	20	15	11
	2010	10	9.4	11	14	21	28	29	28	25	21	15	13
	2011	9.4	8.5	10	15	21	26	29	27	24	18	11	8.7

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	8.5	6.3	9.2	17	23	26	27	29	24	21	16	11
	2013	10	10	13	16	21	25	27	26	25	19	15	9.1
	2014	9.1	7.1	12	15	22	26	27	28	26	18	13	10
Alasht	2006	-1.2	6.1	7.6	13	14	19	18	23	17	16	7.1	-0.1
	2007	4	2.8	3.3	10	16	17	17	21	18	14	9.3	2.4
	2008	-4.2	0.6	13	14	15	16	19	21	19	13	6.2	2.2
	2009	2	5.2	7.9	7	15	18	19	16	16	14	8.2	5.3
	2010	6.5	4.4	8.5	10	15	22	22	21	19	16	11	9.6
	2011	2.6	0.6	5.3	13	16	18	22	19	16	12	2.7	4.2
	2012	2.3	0.9	4.2	13	17	19	18	22	16	14	8	5
	2013	4.7	5.3	9	10	13	16	18	17	19	11	7.9	2.6
	2014	2.8	1	6.2	12	17	19	20	23	18	11	5.4	5.3
Amol	2006	6.4	9.8	13	16	20	27	27	30	25	22	15	8.2
	2007	9	9.1	11	15	22	26	25	27	24	19	14	8.1
	2008	2.8	6.1	14	17	20	23	26	27	25	19	13	8.4
	2009	6.7	9.4	12	12	20	24	26	24	23	19	14	9.9
	2010	9.4	9	11	14	21	27	28	27	24	21	14	11
	2011	8.2	7.6	9.6	15	21	25	28	26	23	18	9.4	7.4
	2012	7.2	5.4	8.6	18	23	25	26	28	23	20	15	9.4
	2013	8.4	9.4	12	16	21	25	26	25	25	18	14	7.8
	2014	8.2	6.2	11	16	23	25	26	28	25	18	12	9.2
Balabeh	2006	-	-	5.8	11	15	21	21	22	18	13	3.8	-3.8
	2007	-2.4	0.2	2	10	15	18	19	21	18	12	6.9	-1.8
	2008	-7.8	-1.3	9.5	12	15	19	20	21	18	12	3.9	-0.7
	2009	-2	1.8	6.1	6.6	15	16	22	19	16	11	5	1.6
	2010	2.7	2	6.7	9.9	15	21	23	19	18	14	6.2	3.7

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2011	-1.9	-1.7	2.2	11	15	20	22	20	16	10	0.3	0
	2012	-1.5	-2.7	1.2	9.9	15	18	20	21	16	12	5.3	1
	2013	-0.1	2.5	5.8	10	13	18	21	19	19	11	5.6	-1.7
	2014	-0.7	-1.5	4.9	11	16	19	22	23	19	10	2.8	1.9

Appendix 3 Monthly precipitation records in synoptic stations

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
Nowshahr	2006	111	44	65.6	75.4	66.2	6.7	27.7	0	335	172	241	182
	2007	76.9	133	141	73.5	26.5	42	47.4	2.5	157	63.9	229	52.6
	2008	163	60.7	18	3.6	34.7	28.8	30.6	37.8	216	213	151	313
	2009	95.9	86.5	122	95.9	34.4	14.7	40.6	84.5	171	126	184	149
	2010	95	109	44.9	74.9	10.3	3	8.5	135	35.4	233	140	33
	2011	132	179	90.4	54.1	15.9	55.8	1.8	198	192	306	355	47.1
	2012	112	126	120	5.8	30.6	62.3	54.8	119	188	133	356	252
	2013	90.8	57.4	117	55.2	26.1	13.5	14.5	52.2	85.3	273	159	175
	2014	69.5	105	103	59.7	3.6	77.9	14.8	10	127	554	196	88.7
Golaleh	2006	74.8	27	60	27.8	32	0.7	0	1	38.5	13.7	196	69.5
	2007	35	71.5	91.9	39.4	25.6	26.5	2.2	1	31	10.9	81.2	61.8
	2008	23.9	39.8	27.3	10.1	22.8	15.5	14.2	1.1	136	82.1	20.7	40.3
	2009	59	88.3	46.5	40.6	10	0	13.1	85.5	137	18	98.1	63.7
	2010	97	71.8	38.9	39	17.9	13.2	0	4.8	10	60.9	6.4	16
	2011	39.3	104	60.5	15.4	4.3	24	0.1	79.1	33.8	204	60.3	41
	2012	60.7	111	84.4	0.8	4.3	108	67.1	14	111	116	64.2	85.1
	2013	79.6	50	100	62.1	55.8	0	26.7	16.6	53.5	30.8	40.6	151
	2014	19.9	26.6	101	26.1	7.1	172	4.9	0.5	45.5	113	98.9	47.4
	2006	74.8	27	60	27.8	32	0.7	0	1	38.5	13.7	196	69.5
	2007	35	71.5	91.9	39.4	25.6	26.5	2.2	1	31	10.9	81.2	61.8
Kiyasar	2006	74.8	27	60	27.8	32	0.7	0	1	38.5	13.7	196	69.5
	2007	35	71.5	91.9	39.4	25.6	26.5	2.2	1	31	10.9	81.2	61.8
	2008	23.9	39.8	27.3	10.1	22.8	15.5	14.2	1.1	136	82.1	20.7	40.3
	2009	59	88.3	46.5	40.6	10	0	13.1	85.5	137	18	98.1	63.7
	2010	97	71.8	38.9	39	17.9	13.2	0	4.8	10	60.9	6.4	16
	2011	39.3	104	60.5	15.4	4.3	24	0.1	79.1	33.8	204	60.3	41

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	60.7	111	84.4	0.8	4.3	108	67.1	14	111	116	64.2	85.1
	2013	79.6	50	100	62.1	55.8	0	26.7	16.6	53.5	30.8	40.6	151
	2014	19.9	26.6	101	26.1	7.1	172	4.9	0.5	45.5	113	98.9	47.4
Kajor	2006	-	-	23.8	23.2	70	0.6	24.7	0	28.3	28.8	56.8	78.6
	2007	18.9	38.7	53.5	28.9	42	38.7	24.1	11.5	14.8	9.9	34	17.9
	2008	20.3	16.8	6.4	8.5	12.7	7.6	13.9	2.7	21.6	36.5	21.1	57.7
	2009	20.3	50.8	38	36.4	15.6	65.9	3	17.5	64	34.1	73.8	15.9
	2010	16.6	37.1	10.2	40.5	16.4	23.2	0.1	27.5	8.6	14.5	33	3
	2011	32.6	31	44.6	12.5	8.9	35.8	5.5	115	19.5	79.1	64.3	18.8
	2012	18.8	20.4	55.3	15.4	24.2	28.7	17.2	33.4	21.9	13.2	50.2	50.4
	2013	16.2	21	37.8	27.8	75.4	3.2	5.6	13.7	6	39.2	27.9	26.9
	2014	7	15.5	22.1	17.2	26.2	53.1	22.8	0	0	33.1	31.8	12
Gilakala	2006	81.2	28.3	41.8	17.9	29.7	8	11.9	2.3	78.7	85.2	117	165
	2007	58.6	105	166	40.6	6.1	39.2	63.9	2.2	58.6	54	141	54.6
	2008	52.6	45.7	26	3.9	19.6	19.4	19.4	19	93.7	162	43.6	73.6
	2009	74.1	66.5	100	76.4	24.4	20.2	4.9	80.1	186	52	207	44.2
	2010	85.7	79.4	37.9	49.4	17.2	9.1	8	61.8	7	67.3	12	28.4
	2011	142	113	80.3	19.9	13.8	44.6	5.3	100	68.3	187	82.5	49.9
	2012	77.4	87.8	78.4	3	1.8	22.5	16.5	43.7	84.4	51.3	145	115
	2013	64.1	46.6	75	40.7	19.9	16.4	20.5	33.4	40.5	110	102	116
	2014	32.7	26.9	70.8	17.7	9.1	32	23.3	4.1	74.5	133	41.8	47.9
Siyahbisheh	2006	79.7	84.9	63.2	72.6	60.8	4.8	23.5	1	7.5	70.3	93.6	75.5
	2007	15.2	70.3	117	138	33.9	35	38.5	7.8	11	10.5	55.4	64.6
	2008	33.6	59.1	11.9	19.5	23.6	7.9	23.8	1.6	28.5	39.6	55.5	81.9
	2009	52.2	74.3	50.1	88.1	29.5	62.8	4.5	23.8	61.1	16.3	80.5	21.7
	2010	27.6	62.4	47.6	94.7	44	2.4	0.8	31.8	12	20	37	15.6
	2011	52.3	67.6	113	60.8	87.2	62.4	18.3	120	15.6	104	142	16.8

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	40.9	53.1	109	54.3	47.8	25.1	50.3	8.3	9.9	23.8	72.1	61.2
	2013	33	26.6	92	32.2	84.8	18	11.3	36.2	2.5	20.6	48.3	110
	2014	29.6	23	61.5	43.1	39.9	28.5	65.8	0	3.7	34.7	71.5	29.6
Sari	2006	69.2	27.8	29.3	19	14.1	0.6	7.5	2	81.4	64.7	103	151
	2007	38.9	95.9	154	36	15.3	47.3	52.2	0.5	33.7	79	148	81
	2008	46	63	27.2	9.4	24.9	31.3	17.5	12.4	111	173	29.6	90.8
	2009	83.2	92.7	108	85.7	33.2	14.3	8.8	107	89.2	69	201	47.1
	2010	86.3	106	66.1	45.7	10.3	5	3.2	12.6	14.1	58.1	10.8	24.1
	2011	155	118	85.7	20.8	19.9	38.9	0.8	87.7	51.1	203	81.5	58.7
	2012	101	175	103	6.9	10.3	54	26.4	39.3	138	75.6	129	149
	2013	82.9	59.3	79.2	39.7	33.7	7.4	14.6	42.6	119	159	104	148
	2014	33.5	25.2	95.4	15.6	5.4	62.1	17.6	0.4	24.7	137	76.8	35.9
Ramsar	2006	78.1	21.8	110	131	42.2	0.4	40.6	0	274	286	194	97.1
	2007	64.5	117	109	124	26.9	36.5	58	15.8	183	53.1	216	106
	2008	100	42.6	1.7	6.1	37.2	120	63.7	67.9	110	151	328	229
	2009	78.3	97.2	63.6	148	18.4	18.4	19.2	124	101	138	93.5	86.7
	2010	44	37.9	85.3	98.8	18.3	2.5	7.5	89.8	98	195	114	23
	2011	59.6	120	127	39.8	10	74.1	3.4	134	270	203	324	50.1
	2012	56.1	64.8	113	7.5	28.9	112	130	86.9	84.2	27.7	171	201
	2013	55.2	26.9	163	24.1	26.7	14.5	66.9	30.2	113	170	143	123
	2014	70.2	226	152	41.8	15.5	25.8	14.8	0.8	156	836	314	81.3
Dashtsari	2006	64.5	21.7	19.4	8.7	9.5	0	3.8	0.7	43.2	35	121	126
	2007	55	86.6	130	22.5	8.9	18.3	26.5	0.1	36.5	42.1	120	72.8
	2008	35.7	40.5	28.4	11.1	13.6	25.8	16.7	11	81.3	88.3	20.9	126
	2009	72.5	85.2	80.6	99.3	17.6	0.9	16	68.8	57.4	79.6	207	74.1
	2010	78.8	118	60.8	36.4	17.7	2.4	0	9.7	18.4	48.9	5.2	18
	2011	106	102	69.7	16.5	14.7	35	0	82.1	43.1	207	102	51.2

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	96.5	133	83.4	4.4	11.6	36.9	15.4	51.3	74.5	63.9	112	174
	2013	65.7	64.7	66.8	34.7	21.7	0.8	11.3	18.8	83.7	143	90.2	129
	2014	25.5	6.5	71.5	10.8	1.1	137	11.3	3	3.9	83.6	77.3	36.6
Polsefied	2006	71.2	10.6	36	44.5	91.5	12.4	51.1	10.3	71.1	48.8	68.9	115
	2007	35.3	75.7	130	29	29.1	26.8	40.7	42.9	28.2	6.8	61.3	46.4
	2008	26.5	61	30.4	11	24.2	39.6	18.4	5.7	44.1	67.1	34.6	64.6
	2009	42.4	86.3	58	65	23.2	42.3	15.2	63.2	46.3	47.9	102	34.1
	2010	28.6	64	25.4	44.4	26.1	8	10.4	19.1	31	40.9	15.3	30.2
	2011	71.8	60.4	82	13.7	16	43.7	12.4	95	43.6	86.9	49.4	32.4
	2012	76.2	106	91.8	18.2	12.2	34.9	42.4	26.1	121	42	89.8	91.8
	2013	38	75.4	48.4	32.8	46.9	15.9	29.8	48.3	38.2	48.2	42.3	80.8
	2014	25.1	32.6	69	34.4	12.2	75.6	43.1	1.4	35.2	62.3	59.3	29.5
Bandaramirabad	2006	79.6	20.5	21.4	12.7	3.4	0	1.8	0	56.1	13.5	140	144
	2007	26	67	140	23.2	2.4	26.2	17.6	7	118	28.2	112	87.5
	2008	53.7	48.7	36	3.2	16.8	6.9	8.9	0.3	92	71.4	28.5	131
	2009	119	80.2	44.4	73.7	5.6	0	17.3	55.5	120	42.6	214	110
	2010	104	117	39.1	23.8	15.1	3	0	58	27.2	80.2	8.3	16.1
	2011	126	100	49.7	5.9	10.7	15.5	0	290	23	329	136	49.5
	2012	94	124	82.8	2.6	24.2	41.4	15.5	19.8	54.6	126	147	148
	2013	74.9	53	42.1	37	21	1.6	4.3	19	10.7	185	80.8	143
	2014	14	12.9	59.1	5.6	2	135	31.2	0.1	29.6	40.5	93.4	34.7
Babolsar	2006	126	14.9	18.5	6.1	6.4	0.2	17.2	0	199	49.4	196	278
	2007	47.4	80.5	147	15.1	5.6	20.3	37.3	5.3	110	110	155	71.2
	2008	157	53.3	11.4	3.6	11.6	10.7	19.9	29.6	120	208	82.8	175
	2009	89	53.6	54.4	81.6	22.8	1.4	12.3	116	158	139	223	117
	2010	114	98.6	27.7	37.8	6.8	3	13.6	29.3	8.3	121	13.1	14
	2011	219	102	58.1	6.3	5.9	52	0	126	76	344	156	61.3

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	104	113	53	7.1	3.2	66.1	40.2	53.5	137	79.7	284	171
	2013	93	49.6	62.2	31.2	22.5	5	10	58.9	98	149	84.9	146
	2014	42.7	63.7	71.6	16.6	8.9	80.7	7.5	0.9	26.3	109	153	51.9
Alasht	2006	43.8	8.5	29.8	24	124	11.3	47.2	5.8	34.8	35.6	45.7	118
	2007	36.1	58	116	40.9	29.2	68.9	53.9	32.8	10.1	14.5	45.8	38.1
	2008	41	68.9	13	12.8	19.2	39.6	34.7	6.8	30.2	49.2	40.3	78.4
	2009	26.8	87.3	42.7	73.1	18.8	48.9	22.4	49.2	43.4	5.1	85.4	29.5
	2010	22.1	75.4	36	48.9	17.9	14.3	79.8	45.7	19.4	28	18.6	23.1
	2011	68.2	63.5	90.3	12.8	18.1	43.4	5.8	94.6	32.8	68.9	69.4	24.4
	2012	70.7	103	93.6	16.2	21.9	10.5	46.4	16	100	29.5	86.8	76.3
	2013	50.6	43.8	45.7	37	44.4	33.1	40.4	51.4	12.3	41.4	42.2	56.3
	2014	23.1	29.3	50.1	40.1	14.2	68.9	28.7	1.9	16.5	54	56.7	19.5
Amol	2006	71.4	17.6	28.7	13.6	40.5	2.2	13.6	0	89.4	32.7	125	140
	2007	42.6	101	99.3	34.7	5.9	18.2	26.7	0	51.6	62.1	131	27.4
	2008	92.1	46.2	17.7	3.9	12.4	22.9	17.6	2.3	96.6	125	28.9	107
	2009	62.8	61.5	94.3	49.1	31.2	10.1	5.6	52.6	86.6	25.9	139	37.1
	2010	78.1	57.9	23.1	37.5	13.4	14.2	8	34.5	18.3	66.9	25.4	14
	2011	90.8	105	69.9	19.2	2.8	39.8	0.3	108	59.1	191	101	34.4
	2012	68.1	87.4	76.4	4	5.4	28.3	41.3	46.8	52.8	49.9	238	133
	2013	77	30.2	69.1	20.5	16.7	5.6	14.6	40.4	60.4	103	103	86.1
	2014	44.7	46.5	65.3	21.5	12.1	37.7	23.2	9	44.4	241	52.1	51.4
Baladeh	2006	-	-	51	29.7	41.1	0	21.1	1	3	37.5	26.8	36.5
	2007	15.5	35.5	44.8	57	27	61.2	23	17.1	5.1	4.1	17.1	37.3
	2008	7	29.5	13.6	10.9	6.7	3.9	34.8	3.3	8.1	14.6	19.7	40.7
	2009	10.7	49.2	25.4	54.1	20.6	93.4	0	1.6	41.7	14.5	64.7	7.2
	2010	8.4	63.4	6	58.5	31.1	7.6	0	35.2	1.2	11	26	10.3
	2011	21.9	33.9	81	22.7	30.7	44.2	25.2	90.9	10.1	80.5	63.9	7.7

Synoptic Station	Year	1	2	3	4	5	6	7	8	9	10	11	12
	2012	14.3	29.7	72.4	21.2	37.4	52	41	8.5	11.7	5.9	29.7	23.3
	2013	20.6	17.1	54	13.8	59.1	15	0.4	23.3	0.8	10.2	12.9	64.7
	2014	4.4	2.1	23.2	24	24.2	29.6	32.2	3	6	14	19.1	15.2

Appendix 4 AHP questionnaire survey

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Hamburg University of Technology

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Institute of Wastewater Management and Water Protection

Questionnaire survey for New Town planning in the Mazandaran province of Iran

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Introduction

The purpose of this study is to establish a scheme of multiple evaluation criteria for the identification of the most appropriate land for establishing *New Town* in the Mazandaran province of Iran. As a part of this research, we are conducting AHP analysis in order to elicit expert's opinion for potential suitable for *New Town* development. As shown in Table A, the evaluation criteria for the identification of appropriate sites are composed of the following stages.

Table A -selected criteria in land suitability analysis

Constrain criteria	Socio-economic-environmental criteria	Validation criteria
Natural protected area Wildlife refuge area Natural park Natural monument	slope-aspect, elevation, geology, soil type, climate type, precipitation, humidity, temperature, sunshine, distance to rivers, distance to electrical grids, distance to cities, distance to roads, land use-land cover, population density, employment, population growth	Land use-land cover

In the following page we would like to obtain your opinion as an expert through a survey questionnaire, in which you are requested to prioritise the aforementioned criteria.

Time to complete survey: The survey will take approximately 20 minute to complete. The completed pdf document is expected to be send by email to: Ali.Zahedi@tuhh.de

Respondent's profile (Optional)

Profession or occupation: _____ Employer name: _____

Have you ever participate in any projects or research related to the town planning and sustainable development?

_____

1. According to your experience, which socio-economic-environmental criterion is more important in each pairwise comparison, and how much? Please mark the numbers representing the intensity of important. If there is any criterion you think unnecessary or unreasonable, please highlight it and leave the check box blank.

2. In addition the mentioned criteria above, are there any other criteria which you think should also be taken into consideration? Or do you have any further recommendation

	More important					More important					
	Absolute	Very Strong	Strong	Slight	Equal	Absolute	Very Strong	Strong	Slight		Uncertain
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Elevation	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Geology	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Geology	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Soil type	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Climate type	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Precipitation	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Humidity	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Temperature	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to cities	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Slope-Aspect	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Geology	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Soil type	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Climate type	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Precipitation	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Humidity	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Temperature	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□

	More important					More important					
	Absolute	Very Strong	Strong	Slight	Equal	Absolute	Very Strong	Strong	Slight		Uncertain
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to cities	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Elevation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Soil type	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Climate type	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Precipitation	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Humidity	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Temperature	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distatance to electrical grid	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to cities	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Geology	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Climate type	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Precipitation	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Humidity	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Temperature	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to Cities	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□

	More important					More important				
	Absolute	Very Strong	Strong	Slight	Equal	Absolute	Very Strong	Strong	Slight	Uncertain
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Soil type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Precipitation	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Humidity	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Temperature	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to Cities	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Climate type	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Humidity	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Temperature	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to Cities	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Precipitation	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Temperature	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□

	More important					More important					
	Absolute	Very Strong	Strong	Slight	Equal	Absolute	Very Strong	Strong	Slight		Uncertain
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to Cities	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Humidity	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Sunshine	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to Cities	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Temperature	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to river	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to Cities	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Sunshine	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Distance to river	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to electrical grid	0□
Distance to river	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to cities	0□
Distance to river	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Distance to river	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□

	More important					More important					
	Absolute	Very Strong	Strong	Slight	Equal	Absolute	Very Strong	Strong	Slight		Uncertain
Distance to river	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Distance to river	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Distance to river	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Distance to electrical grid	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to cities	0□
Distance to electrical grid	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Distance to electrical grid	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Distance to electrical grid	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Distance to electrical grid	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Distance to electrical grid	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Distance to cities	9□	7□	5□	3□	1□	3□	5□	7□	9□	Distance to roads	0□
Distance to cities	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Distance to cities	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Distance to cities	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Distance to cities	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Distance to roads	9□	7□	5□	3□	1□	3□	5□	7□	9□	Land Use-Land Cover	0□
Distance to roads	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Distance to roads	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Distance to roads	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Land Use-Land Cover	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population density	0□
Land Use-Land Cover	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Land Use-Land Cover	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Population density	9□	7□	5□	3□	1□	3□	5□	7□	9□	Employment	0□
Population density	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□
Employment	9□	7□	5□	3□	1□	3□	5□	7□	9□	Population growth	0□

Appendix 5 Maps

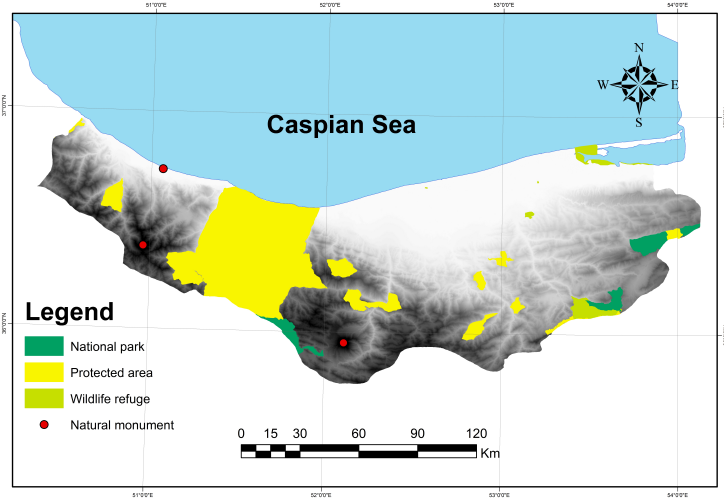


Figure A-1 Map of protected area in the Mazandaran province of Iran

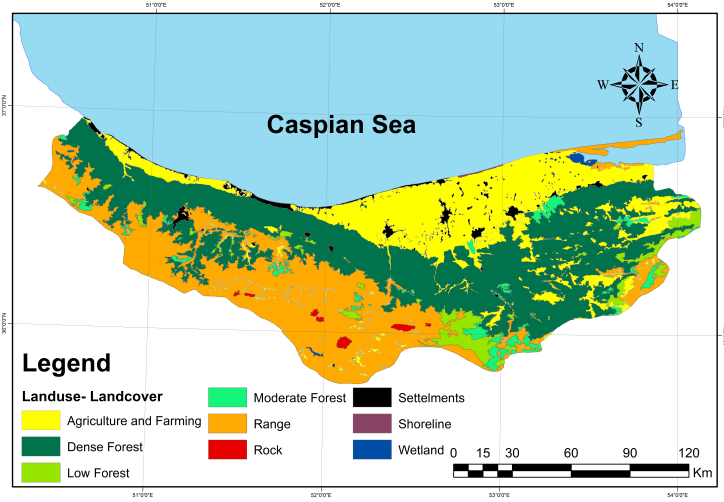


Figure A-2 Map of land use-land cover in the Mazandaran province of Iran

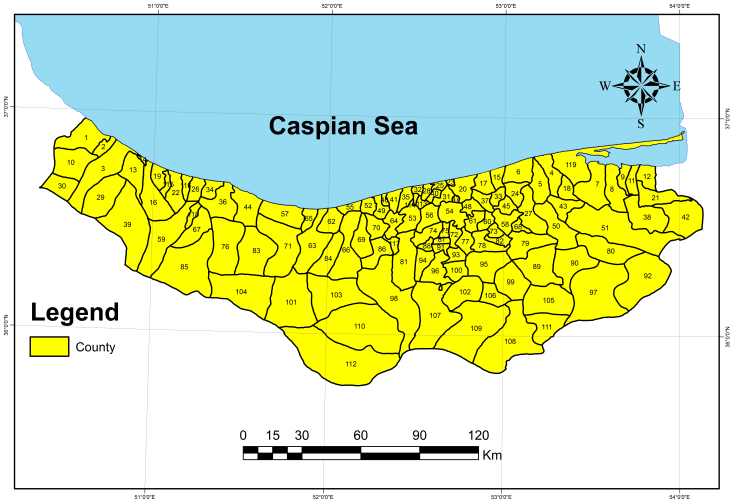


Figure A-3 Map of counties in the Mazandaran province of Iran

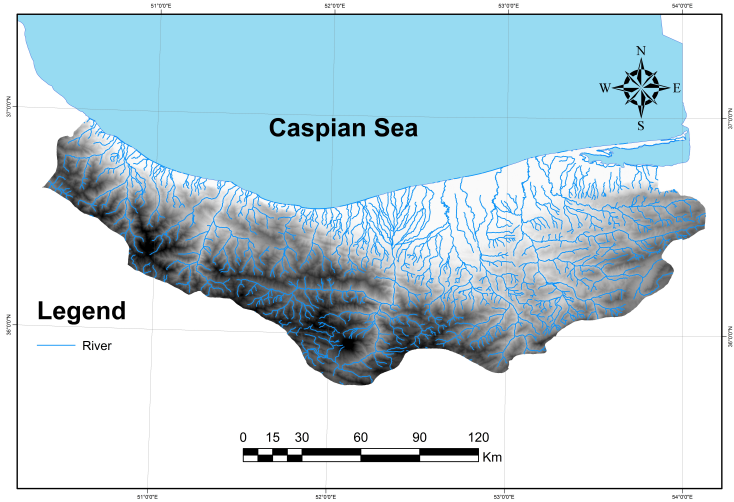


Figure A-4 Map of rivers in the Mazandaran province of Iran

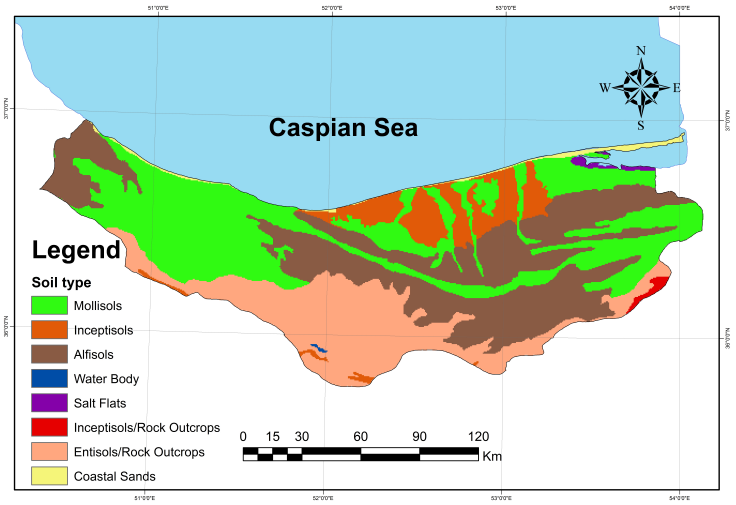


Figure A-5 Map of soil types in the Mazandaran province of Iran

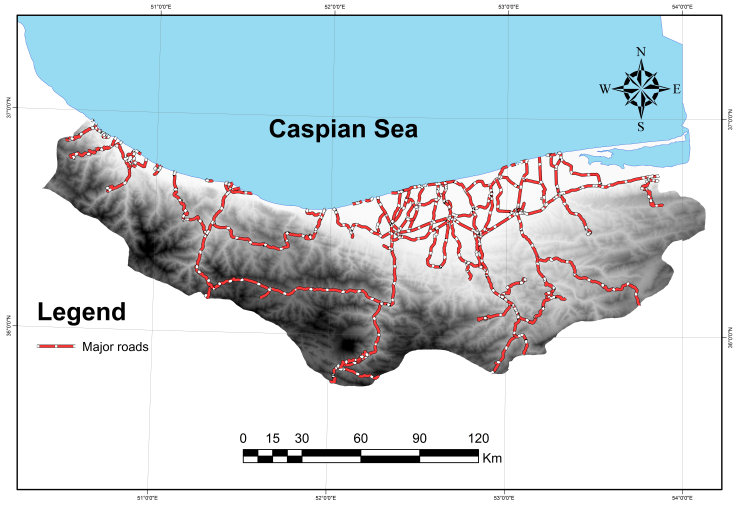


Figure A-6 Map of major roads in the Mazandaran province of Iran

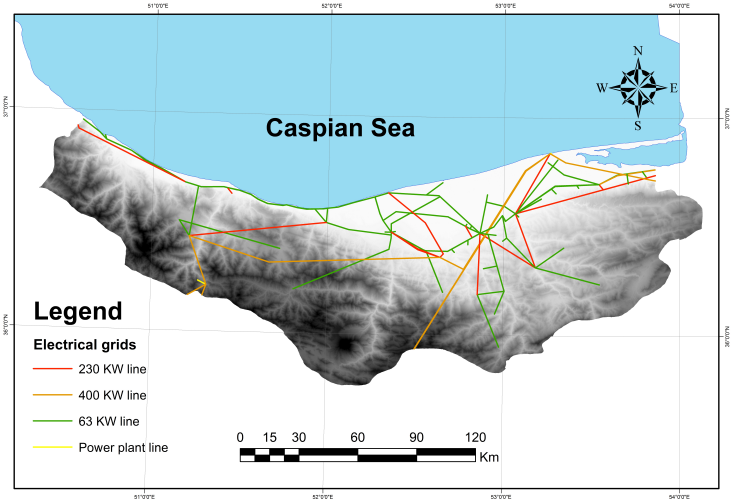


Figure A-7 Map of electricity grids in the Mazandaran province of Iran

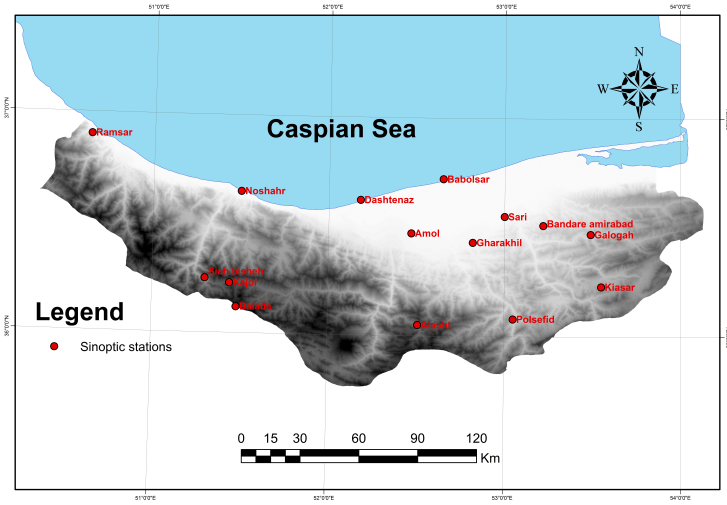


Figure A-8 Location of synoptic stations in the Mazandaran province of Iran

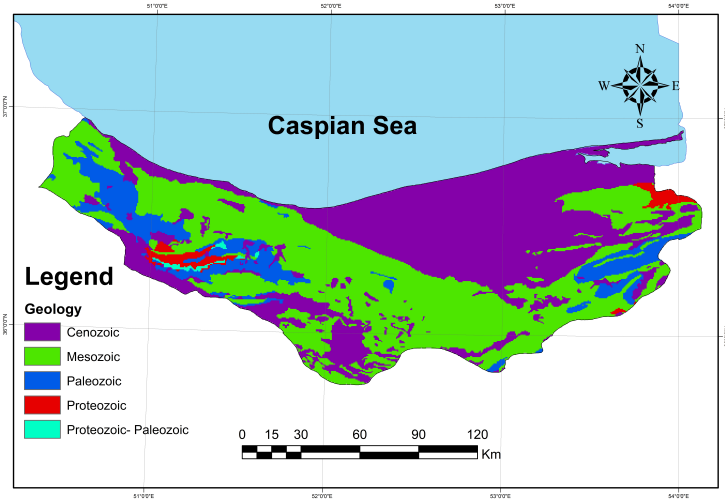


Figure A-9 Map of Geology in the Mazandaran province of Iran

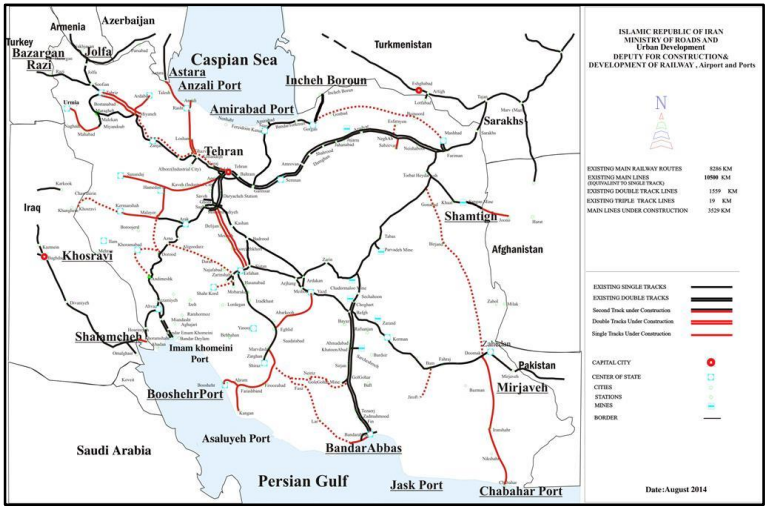
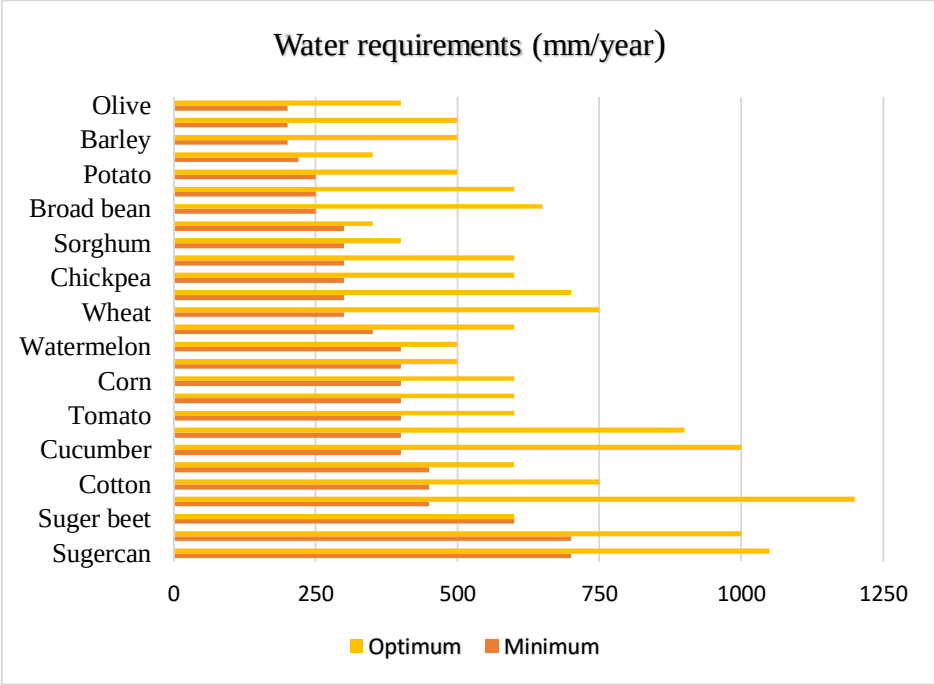


Figure A-10 Map of railways in Iran

Appendix 6 Water requirements for selected crops (extracted from FAO Ecocorp Database)



Appendix 7 Areal and percentile distribution of the selected criteria and sub-criteria in the province of Mazandaran

Main criteria	Sub Criteria	Area (Km^2)	Area (%)
Aspect-Slope	N, E, S,W (≤10%), Flat	4,917.57	20.63
	N (10−15%)	572.85	2.40
	N (15−20%)	485.41	2.04
	N (20−25%)	485.56	2.04
	N (25−30%)	503.30	2.11
	S (10−15%)	407.44	1.71
	S (15−20%)	333.26	1.34
	S (20−25%)	335.12	1.41
	S (25−30%)	349.92	1.48
	E (10−15%)	362.41	1.52
	E (15−20%)	324.60	1.38
	E (20−25%)	329.25	1.39
	E (25−30%)	332.45	1.39
	W (10−15%)	391.84	1.64
	W (15−20%)	352.11	1.48
	W (20−25%)	337.60	1.42
	W (25−30%)	326.00	1.37
	N, E, S, W (≥30%)	12,694.31	53.25
Elevation (m)	-80−0	2,716.42	11.39
	0−500	4,688.77	19.67
	500−1,000	3,009.38	12.62
	1,000−2,000	6,063.54	25.43
	2,000−4,000	7,275.41	30.52
	>4,000	87.48	0.37
Geology	Cenozonic	10,364.40	43.47
	Mesozoic	10,570.73	44.34
	Paleozonic	2,380.81	9.98
	Proterozonic	445.15	1.87
	Proterozonic- Paleozonic	79.91	0.34
Soil Type	Alfisols	7,807.76	32.76
	Inceptisols	2,020.38	8.47
	Mollisols	8,495.62	35.63
	Costal sands	314.86	1.32
	Rock Outcrops-Entisols	4,993.07	20.94
	Rock Outcrops-Inceptisols		
	Salt Flats	90.94	0.38
	Water body	106.15	0.45
		12.22	0.05
Climate type	Semi-Arid	594.45	2.49
	Mediterranean	7,834.12	32.86
	Semi-Humid	11,121.46	46.65

Main criteria	Sub Criteria	Area (Km^2)	Area (%)
	Humid	2,243.73	9.41
	Very Humid	2047.24	8.59
Precipitation (annual & accumulative)	26−42 mm	905.39	3.79
	43−53 mm	9,864.38	41.37
	54−64 mm	9,545.07	40.04
	65−83 mm	2,175.53	9.13
	84−110 mm	1,350.63	5.67
Humidity (Average annual relative)	55−60%	1,060.07	4.45
	60−65%	2,635.15	11.05
	65−70%	7,908.59	33.17
	70−75%	9,453.10	39.65
	75−80%	2,784.09	11.68
Temperature (Average annual)	10−12 (°C)	180.83	0.76
	12−14 (°C)	10,123.84	42.46
	14−16(°C)	8,065.36	33.83
	16−18 (°C)	4,471.52	18.76
	18−20 (°C)	999.45	4.19
Sunshine (Cumulative annual)	1,950−2,150 hours	1,269.89	5.32
	2,150−2,350 hours	5,668.52	23.78
	2,350−2,550 hours	15,680.26	65.77
	2,550−2,750 hours	1,101.09	4.62
	2,750−2,950 hours	121.24	0.51
Distance to river	0−1 Km	12,879.70	54.02
	1−2 Km	7,793.05	32.69
	2−3 Km	2,257.08	9.47
	3−4 Km	706.63	2.96
	> 4 Km	204.54	0.86
Distance to electrical grid	0−10 Km	14,852.35	62.30
	10−20 Km	4,984.77	20.91
	20−30 Km	2,800.83	11.75
	30−40 Km	1,069.17	4.48
	40−50 Km	133.88	0.56
Distance to cities	0−10 Km	9,414.37	39.48
	10−20 Km	9,527.33	39.96
	20−30 Km	4,178.25	17.53
	30−40 Km	718.98	3.02
	>40 Km	2.07	0.01
Distance to roads (main roads)	0−10 Km	18,487.78	77.55
	10−20 Km	4,570.36	19.17
	20−30 Km	739.24	3.10
	30−40 Km	43.62	0.18
LULC	Low Forest, Moderate Forest, Dense Forest	10,769.73	45.17

Main criteria	Sub Criteria	Area (Km^2)	Area (%)
	Urban settlements	508.67	2.13
	Range	6,788.32	28.47
	Rock		
	Agriculture and Farming	101.40	0.43
	Shoreline	5,585.82	23.43
	Wetland	14.31	0.06
		72.75	0.31
Population density rate (persons/Km^2)	0−5	4,229.02	17.74
	5−20	9,689.57	40.64
	20−100	5,416.59	22.72
	100−200	2,899.93	12.16
	200−1,000	1,605.88	6.74
Employment rate	29−37%	5,217.87	21.89
	37−44%	16,339.99	68.54
	44−51%	2,091.51	8.77
	51−66%	191.63	0.80
Population growth rate (for rural settlements)	-12− 0%	10,091.16	42.33
	0−6%	12,321.39	51.68
	6−12%	467.76	1.96
	12−18%	331.07	1.39
	18−22%	629.62	2.64