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Green-oriented planning for shrinking cities through an integrated ecosystem services/disservices analysis: A Case of Minoo Island, Iran

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Abstract: The number of shrinking cities is rapidly growing and posing new planning and design challenges worldwide. In this regard, understanding urban decline from an integrated ecosystem services/disservices perspective is limited in the literature and is considered as a critical basis for revitalization programs. Minoo Island as one of the emerging shrinking cases in Middle East has considerable characteristics in terms of both positive and negative aspects of ecosystem in population decline. This paper aims to investigate various ecosystem factors resulting in urban shrinkage in Minoo Island as a consequence of the Iran-Iraq war in 1980s. The research method of this study is based on qualitative assessment of ecosystem services/disservices by using participant observation and semi-structured interviews. An integrated ecosystem services/disservice analysis was applied for assessment of ecological functions and assets. The results of this paper show that despite remarkable ecosystem potentials and functionalities in Minoo Island, it suffers from detrimental effects of ecosystem disservices leading to population decline over the past decades. Finally, this paper proposed some green-oriented design and planning strategies such as ecological protection, river restoration and green infrastructures for revitalizing Minoo Island.

1. INTRODUCTION

Urban shrinkage is not a new phenomenon; however, it is among today's key debates due to its growing rate in recent years. In recent years, the shrinking cities are widespread over Asia (Haase, A. et al., 2014). Generally, a shrinking city can be defined as one that has a smaller population or economy than in the past; nevertheless, even a time threshold can evoke an arbitrary classification (Herrmann et al., 2016). This concept applies to south of Iran suffering from political conflicts, natural disasters, increasing unemployment rates and a rapid decrease in birth rates. While there is an extensive debate in European, American, Asian, and African countries about shrinking cities, the case of Iran and especially small islands has been given limited attention in the literature (Reckien & Martinez-Fernandez, 2011; Khavarian-Garmsir et al., 2019).

Most previous studies indicated socioeconomic status including population loss and economic decline as main causes and drivers for urban shrinkage (Oswalt, Philipp & Rieniets, 2006; Hospers, 2013; Haase, A. et al., 2014; Lee, Won, & Kim, 2016). In addition, although some researchers have suggested war, genocide, natural catastrophes (e.g. flood) as ecological and political factors which can force urban shrinkage (Oswalt, Philipp & Rieniets, 2006; Haase, 2008; Hollander et al., 2009; Rieniets, 2009; Reckien & Martinez-Fernandez, 2011; Großmann et al., 2013; Asano, Lee, & Mykhnenko, 2018); there is limited detailed study regarding the explanation of these connections. For example, Khavarian-Garmsir et al. (2018) believe that urban shrinkage has highest impacts on economic and environmental aspects of cities. Reckien and Martinez-Fernandez (2011) indicate the political conflicts and war as major drivers of urban shrinkage in Iran; however, they do not further explanations about the processes and mechanisms.

The Minoo island is one of the remarkable shrinking cases in south of Iran. The shrinkage in Minoo as a border city of Khuzestan province rooted in the political conflicts between Iran and Iraq in 1980s in which a wide variety of ecosystem services were affected. Many of the ecosystem's components, built environment and infrastructures of this region as well as some other cities in Khuzestan province such as Abadan were tremendously destroyed in face of the Iran-Iraq war (Pourahmad, 1994; Khavarian-Garmsir et al., 2018). This paper does not persuade to present stereotypes behind social and economic decline resulting in Minoo shrinkage but rather the emphasize of this paper is focusing on the ecosystem services (ES) and ecosystem disservices (EDS) analysis in order to highlight environmental degradation as main factor of urban decline in this region. In this respect, ES and EDS are defined generally as positive (e.g. food supply) and negatives (e.g. pollen allergies) impacts of ecosystems, respectively.

This study aims to investigate an integrated ecosystem services/disservices approach to clarify to the extent that each ecosystem's components of the island has its own positive and negative effects in urban decline. There is limited such a study in which both positive and negative outputs of a component are analyzed (Von Döhren & Haase, 2015) and then can be used as a basis for urban planning/design strategies. The target is to improve the importance of the role of ES/EDS analysis in urban planning and design process in different cases specially shrinking communities. Since considering the use of land and nature and their relationships are primary goals of urban planning and design fields, as Wilkinson et al. (2013) state there is a clear link between these fields and ES/EDS in order to address environmental policies and plans in urban development process. To clarify some important points and future considerations, this paper discusses the experience of a Master Plan of Minoo island aimed at enhancing the overall provision of ecosystem services. The paper proceeds as follows: first, the literature review of concepts in relation to ES/EDS, urban shrinkage, green-oriented planning and river restoration as main components of theoretical and practical body of the paper are presented. In the next section, it is attempted to qualitatively analyze the items of ES/EDS in Minoo Island in southwestern of Iran.

2. OVERVIEW OF THE STATE OF THE ART

Urban ecosystem services have multi benefits for human health and well-being in the face of rapid urbanization, land-use transformation and climate change crisis (Han, Kang, & Song, 2018). Urban ESs are generated in two

diverse set of green and blue infrastructures including but not limited to parks, urban forests, farmlands, vacant lots, gardens, streams, ponds, and rivers. Cities are dependent on healthy ecosystems and their benefits for human well-being. Ecosystem services (ES) can be defined as "the benefits people obtain from ecosystems" (MA, 2005). Urban ecosystem services can be divided into four categories according to the Millennium ecosystem assessment (2005): provisioning services, regulating services, habitat or supporting services and cultural services. Furthermore, sometimes ecosystem has detrimental effects which are harmful for people and their environments called 'ecosystem disservices' (EDS) which is less developed in the literature (Von Döhren & Haase, 2015).

According to Lyytimaki and Sipila (Lyytimäki & Sipilä, 2009), ecosystems disservices is defined as "functions of ecosystems that are perceived as negative for human well-being" which can result from natural or political phenomena such as floods, earthquakes, wildfires or wars. Although some studies have divided EDS into different categories (Lyytimäki, 2014; Von Döhren & Haase, 2015; Shackleton et al., 2016; Vaz et al., 2017), there is no consensus for EDS classification in comparison with ES (Shackleton et al., 2016; Vaz et al., 2017; Campagne, Roche, & Salles, 2018; Wu, Huang, & Li, 2020). As Blanco et al. (2019) state, investigating EDS will improve our understanding of coupled human-nature environments which help reach to more sustainable goals.

2.1 Urban Shrinkage

A shrinking city is often defined by some features including population loss, economic decline or neighborhood quality reduction in the planning literature (Clark, 1989; Kim, 2019). According to Hasse et al (Haase, A. et al., 2014), urban shrinkage debate is mainly structured around some explanations including "counterurbanization" meaning the devaluation of inner-city's stock flow in combination with overcrowding, "suburbanization" meaning the dominant trend of residents to urbanize on the city periphery resulting in depopulation of core city, "accumulation of capital" meaning the uneven development of investment resulting in unattractiveness of some parts of the city.

Also, there is a clear linkage between urban shrinkage and urban sustainability issues (Slach et al., 2019). Vacant lands or brownfields are typically served as signs of most shrinking cities like Minoo in this study (Fritsche et al., 2007; Rieniets, 2009; Newman et al., 2016). In general, vacant lands can supply a wide range of diverse ES such as stormwater management, public spaces, microclimate regulation, habitat services and urban agriculture (Nefs et al., 2013; Mathey et al., 2015; Newman et al., 2016); however, as D. Newman et al. (2016) state the increased vacant lands can cause detrimental effects for human well-being, population migration, housing crisis, contamination and land assembly problems. Some authors indicate the vacant land as a great opportunity for leveraging sustainability indicators thorough ES (Nefs, 2006; Burkholder, 2012; Herrmann et al., 2016).

2.2 ES/EDS in shrinking cities

The urban shrinkage have been consistently studied in literature from economic and demographic change perspectives (Oswalt, P, 2005; Martinez-

Fernandez & Wu, 2007; Haase, 2008; Wiechmann, 2008; Buhnik, 2010; Hollander, 2010; Wiechmann & Pallagst, 2012; Bernt et al., 2014; Hartt, 2018); however, little work has been done from the environmental point of view to analysis shrinking cities (Asano, Lee, & Mykhnenko, 2018) and generally there is no study for assessment ES/EDS in these cities specially Middle East shrinking cases such as Iran which need to be taken into consideration from different point of view (Khavarian-Garmsir et al., 2018).

Doubtless, the linkage between ES/EDS and urban shrinkage cannot be understood without referring to articles titled "Conceptualizing the nexus between urban shrinkage and ecosystem services" and "Shrinking cities and ecosystem services: Opportunities, planning, challenges, and risks" which have been published in Landscape and Urban Planning and Atlas of Ecosystem Services, respectively. These papers are the only studies which have directly attempted to link these terms and a few studies have inaccurately addressed this relationship (Haase, 2008; Schilling & Logan, 2008; LaCroix, 2011; Kroll et al., 2012); however, they just address ecosystem services provisioning and do not include other categories of regulating, socio-cultural and supporting services. These papers also focus on land use/cover factor which can provide ES in shrinking cities and do not include other indicators.

2.3 ES/EDS in urban planning and design

Cities depend on urban ecosystem and its vital services to sustain human well-being (Gómez-Baggethun & Barton, 2013). It is increasingly recognized that urban planners and designers have remarkable concerns regarding the incorporation of different provisioning, socio-cultural and regulatory ES into urban planning for improving quality of life in cities (Colding, 2011). Yet, as compared to other related fields such as urban forestry, landscape ecology and ecological economics, the attention given to planning and design discourses regarding ES/EDS is relatively modest. The most studies in analyzing ES and EDS have been accounted for plant diversity, forestry and urban trees and the number of studies which incorporate these concepts into planning and development process are still low (Escobedo, Kroeger, & Wagner, 2011). While urban areas basically depend on ecosystem services, understanding disservices help urban planners understand trade-offs associated with different urban green spaces (Klimas et al., 2016).

Undoubtedly, there is a strong relationship between ES/EDS and ecological planning and design in urban areas. Although the notion of ES has been applied for urban studies, EDS have seldom been considered in the context of urban development process. The linkage between ES and urban planning and design has been mostly clarified by applying three types of sectional planning: land use planning, spatial planning and ecological landscape and conservation planning (Yu et al., 2011; Casado-Arzuaga et al., 2014; Lauf, Haase, & Kleinschmit, 2014; Baró et al., 2016; Langemeyer et al., 2016; Almenar et al., 2018) and more recently adaptive urban planning and design (Ahern, Cilliers, & Niemelä, 2014) and regenerative urban design (Zari, 2015). For example, spatial scales and landscape structure affect the possibilities and constraints for ecosystem service planning.

Although the term 'ecosystem service' has not been considerably used in urban planning and design documents (Rinne & Primmer, 2016), urban planners and designers among others, explicitly use the benefits of urban ecosystem services such as urban vegetation, green and blue spaces and infrastructures in relation to food supply, cooling, pollutant reduction, noise reduction, aesthetics, recreation and cognitive development, social relations in

their plans to make future urban environments more sustainable. By contrast, they can ameliorate or ignore the negative impacts of urban ecosystems as EDS in mostly local scale such as water quality reduction, noisiness, displacement of endemic species, air quality decline or health diseases which are still not widely enough discussed in the literature (Haase, D. et al., 2014; Von Döhren & Haase, 2015). For example, Woodruff & BenDor (2016) analyse two comprehensive plans in Oregon and Ohio states in United States for demonstrating ecosystem services application.

2.4 Green-oriented planning for urban shrinkage

Different planning and design responses to urban shrinkage such as urban densification, urban tourism, social initiatives, right-sizing, land use change, large-scale redevelopment, adaptive reuse , ecological restoration and nature-based solutions have been proposed so far by urban planners and designers (Oswalt, P, 2005; Dettmar, 2006; Schilling & Logan, 2008; Hollander et al., 2009; Schenkel, 2015; Lee, Won, & Kim, 2016; Blau, Luz, & Panagopoulos, 2018; Kim, 2019); however, there is no clear consensus across urban designers and planners on shrinking cities planning strategies (Kim, 2019). In this respect, applying ecological principals in urban land planning and design as green-oriented planning for revitalizing cities has been a strong planning approach in recent years (Turner, 2006). In parallel to the green-oriented planning, Wikantiyoso and Suhartono (2018) focus on the "green open space revitalization program" which in turn can results in enhancing quality of life, and comfortable city life. Such green-oriented planning approaches provide multi benefits especially in the face of global warming and climate change through creating a balance between built environment and environmental conservation (Wikantiyoso & Tutuko, 2013).

Although the planning literature has recommended that incorporating ES into plans can add potential to address environmental issues during the urban development process (Albert et al., 2016; Nin et al., 2016); the majority of proposed urban design strategies in the literature to cope with urban shrinkage do not include environmental approach and often suggest visual, physical, social or functional strategies (Ryan, 2012; Kim, 2019). As Yu et al. (Yu et al., 2011) state, the planning of urban greening has significant impacts on urban sustainable development. Green-oriented planning strategies can provide urban green spaces (UGS), food, ecological benefits, biodiversity, energy efficiency, and amenity for urban environments (Prior, 2016; Bolleter, 2018; Liu, Te Pai, & Lin, 2018).

The urban green/blue infrastructure as integral parts of provisioning, socio-cultural and regulatory ES have considerable impacts on human well-being, urban health and quality of life (Gómez et al., 2011; EC-European·Commission, 2013; Lovell & Taylor, 2013; Frazier & Bagchi-Sen, 2015; Mathey et al., 2015). In green-oriented planning, UGI and UBI are expanded and renewed (Ortiz-Moya, 2020). A network of green/blue sites such as urban parks, green roofs and facades, and street trees as the most important outcomes of green-oriented planning, can also lead to a healthy urban planning and design of cities. They support healthy cities through providing habitat services, microclimate regulation, stress reduction and recreational areas (Palmer, Hondula, & Koch, 2014; Mathey et al., 2015; Blau, Luz, & Panagopoulos, 2018).

3. METHODOLOGY

3.1 Case study area

The research was conducted in Minoo Island, in southwest Iran, located about 100 km of Ahvaz city of Khuzestan province (*Figure 1.*). The Minoo Island is characterized by a 2000-acre flat land covered by palm trees and streams located at the intersection of two major rivers: Big Arvand river (BA) and Small Arvand river (SA). In addition, there are 12 inner streams that flow into the two rivers. It has a hot-arid climate with annual temperature of around 30-35 o. To be more precise, Minoo Island currently has been covered by vacant lands in the south (80%), farmlands (10%), and residential areas in the north (3%), roads (5%) and other land uses (2%) (ArmanshahrCompany, 2017). The abrupt collapse of the Minoo's economic and social order led to escalating unemployment rates, accompanied by a dynamic out-migration to the regions of Abadan and Khoramshahr and a dramatic drop in birth rates. In the first half of the 1980s, Iran faced a war with Iraq and Minoo was one of the cities where experienced a considerable economic and ecological damages due to its location on the fringe of South of Iran.

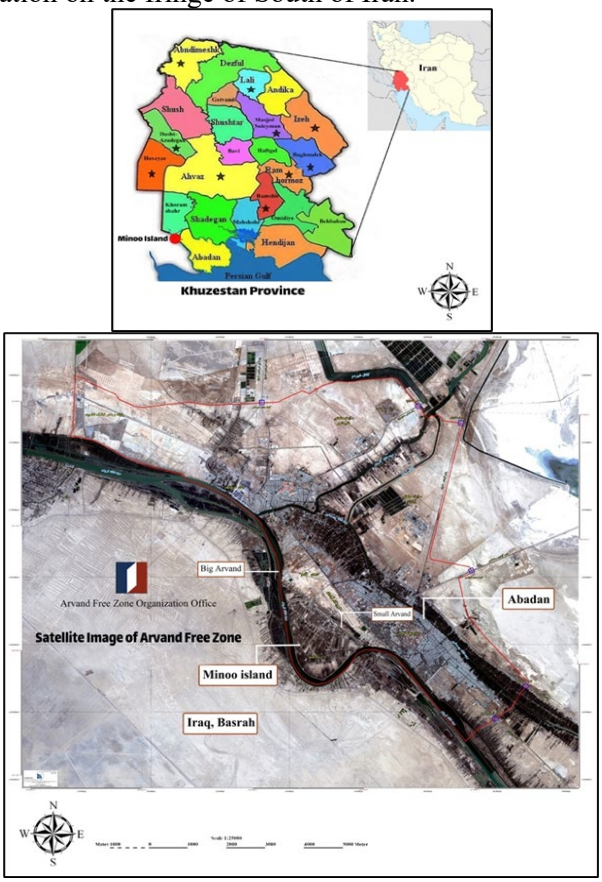

Figure 1. Location of the Minoo island within the greater Arvand free zone, Khuzestan province and Iran (Source: Arvand Free Zone Organization)

Its apparent green historical form understandable from satellites, geopolitical advantage due to its borderline with Iraq, and convenient communications by outer and inner rivers and palm trees make Minoo one of the important southern areas of Iran. However, accompanying with detrimental consequences of Iran-Iraq war in 1980s and the ignorance of both

public and private sections to revitalize it, Minoo has been increasingly facing some social, economic and environmental problems after the war, as follows:

1. Over the last decade, the island faced a profound population loss. Due to this trend, the population decreased from 9250 in 1975 to 7775 in 2015 (Statistical·Center·of·Iran, 2014) (*Table 1*). According to the national statistical center's report, only 15% of Minoo's population are working on service-based jobs out of the island and the majority of Minoo's residents suffer from unemployment resulting from post-war economic decline; while, they mostly worked on their own farmlands to produce dates and related industries before the war in 80s because of Minoo's population began to stabilize more recently due to this fact that the renewal plan is currently under implementation which in turn will result in re-growth of the island in the future.

Table 1. Population growth variation in Minoo Island from 1975 (before war) to 2015

	Population size			**Absolute change**		**Population growth rate**
	1975	1995	2015	1975-1995	1995-2015	**(1975-2015)**
Minoo island	9250	8800	7775	- 450	- 1025	- 0.39

Source: Official census of Iran in 2015

2. The environment of Minoo Island is based on two basic elements of streams and palms. The irrigation systems in Minoo Island had been based on tidal mechanism in the past and there were no any mechanical pumps. The island lacks of drainage and sewage system. The majority of rivers have been polluted by mud/silt and the ground/surface water is unsafe and unhealthy for residents' usage. The island's local streams which were historically used for irrigation, have been gradually covering by greywater (ArmanshahrCompany, 2017).
3. A significant number of palm trees have been dried due to the salt water of the rivers and dry and hot climate of the island.

3.2 Methodological approach

It is important to consider ecosystem disservices to fully understand the impact of ecosystems on human well-being. This is especially important in the context of shrinking cities where human attitudes, needs and general socio-economic content can be subjective and diverse as previously mentioned. To analyze whether ecosystem disservices had significant impacts on emergence of urban shrinkage in Minoo, we conducted an integrated assessment of ecosystem services (ES) and ecosystem disservices (EDS) which is supposed to fulfil different social, ecological and economic aspects of shrinking cities.

Although EDS have been indicated in some studies, a comprehensive conceptual framework that incorporates both EDS and ES is lacking (Vaz et al., 2017). Lyytimaki (Lyytimäki, 2014, 2015) and Biggs , Schlüter, & Schoon (2015) indicate the importance of integrative ES and EDS analysis in order to create a balanced and comprehensive recognition of ecosystem functioning in urban areas, and particularly, its application in urban planning, urban environmental management and policy-making. A qualitative approach

for ES/EDS assessment was selected due to its benefits covering more sides of the issue than a quantitative or monetary valuation. The main benefit of this approach in shrinking cities such as Minoo Island is its simultaneous ability to present both positive and negative effects of ecosystem on population decline which help planners and policy makers make sustainable decisions according to the socio-ecological assets. This approach builds on the statement given by Von Dohren and Haase (Von Döhren & Haase, 2015), which indicate complementary nature of ES and EDS which can be either beneficial or detrimental for people. Although this new approach was applied in this study, the number of similar studies is still low and needs to be more clarified from different experts' perspectives including but not limited to ecologists, hydrologists, human geographers and sustainability scientists.

3.3 Data collection methods

In this article, we draw on ethnoecological research including qualitative methods according to Rasmussen et al. (Rasmussen et al., 2016) with stakeholders of Minoo Island, Khuzestan in Iran. In this regard, to assess ES in Minoo Island, it is critical to explore different social actors' demand and their actual benefit experienced by residents of the island.

Data for the field study was gathered between December 2018 to August 2020. Most data were acquired through participant observation including landscape walks conducted in the research area and semi-structured interviews with a group of regional experts and local residents. According to Cresswell & Plano Clark (2017), the purposeful sampling method was used in this paper for the identification and selection of information-rich persons who are especially knowledgeable or experienced with Minoo's current and past situations. So, the sample size consisted of totally 50 interviewees contains 10 municipality and Arvand free zone organization's officials who were experienced with Minoo's development process, five local residents as members of the island's council and 35 nonofficial residents as representors of previous and current ES and EDS in Minoo island (*Table 2*). The experts were selected according to their local knowledge about Minoo island's natural resources and ecosystem status. The local 35 residents were selected according to their long-term residence (more than 40 years) in Minoo Island. With regard to the understanding different components of ES and EDS in area, both officials and local residents of the island were asked questions (see Appendix 1) about the past applications and conditions of palms trees, rivers, and farmlands as major elements of Minoo's ecosystem (e.g., recreation, timber supply, food supply, date production, animals, irrigation system, etc.).

Table 2. List of the regional group interviewed, their affiliations

Sector	Expert	Organization	Number of interviewees
Water management	Engineer	Municipality of Abadan	1
Tourism	Director	Arvand Free Zone	1
Urban planning	Major coordinator Administrator	Arvand Free Zone Municipality of Minoo	6
Natural resources	Administrator	Arvand Free Zone	2
Non-expert residents	-	-	35
Local council	-	City council	5

As mentioned, the emphasis in this study is on exploring the values associated with main ecosystem services and disservices of the island across agricultural fields, rivers, palm trees, and vacant lands for stakeholders and growth coalitions. So, it is not dependent on data concerning ecological status of different parts of the island. To end this, the research area was physically divided to ten almost equal parts and participatory fieldworks were done for each part in a 4-hour session during 8 months starting from December 2018. All field notes regarding ecosystem services and disservices as well as considerable points stemming from conversations with locals were collected and recorded and then were analyzed.

3.4 Data analysis methods

As previously mentioned, semi-structured interviews were used to introduce ES before the war as compared to the present condition and obtain each local residents' opinion. In the second step, to investigate which ecosystems services/disservices have significant influences in emergence and/or reduction of urban shrinkage in Minoo, we attempted to fully assess the island's farmlands, rivers, streams and palm trees through using qualitative and quantitative data generated from previous official textual and pictorial documents, satellite google maps and semi-structured interviews in addition to our own field study which were thematically analyzed as management of either ES or EDS in Minoo island.

The feedbacks and data gathered from fieldworks and local conversations were analyzed and categorized by using qualitative content analysis. During the walks across the palm trees, streams and vacant lands, additional information about provisioning and socio-cultural ecosystem services were provided through recording and then interpreting all data gathered from field works.

4. RESULTS

Ecosystem degradation rapidly occurred after the war in 1980s because of its detrimental effects on blue and green infrastructures. Since the majority of islanders' jobs were related to natural resources services before the war, they abandoned the island after the war to seek new job opportunities out of the Minoo. As a result, not only ecosystem was no longer beneficial for the residents, it caused disservices, in turn, resulted in population decline. After

interviewing with 50 Community leaders, local residents as well as the island officials, we summarized total transcripts into some categories including major ecosystem services and disservices of the Minoo. *Table 3* presents the number of times the value was discussed across persons.

Table 3. Frequency of ecosystem services/disservices occurrence by interviewees

Value	Before the war	After the war	Number
Fresh water	×		50
Tourism	×		45
Date production	×		50
Aesthetics of rivers and palms	×		44
Fishing industry	×		43
Farmland's productivity	×		50
Pest regulation	×		35
Natural irrigation	×		46
Vacant lands		×	41
Canebrakes		×	38
Sandstorms		×	32
Wildlife habitat	×	×	43
Biodiversity	×		45
Soil contamination		×	34
Recreational activities	×		49
Dark green areas		×	39
Shading	×		40

4.1 Blue services/disservices

Firstly, ecosystem of Minoo Island has been heavily deteriorated since the war in 1980s according to the report by Natural Resources trace of Arvand Free Zone Organization (Natural Resources – Arvand Free Zone (AFZ), 2008). In the past, the irrigating of palms as well as surface/run off water drainage were carried out by local streams in the island which was based on a tidal system. In this case, island's farmlands were being naturally irrigated through water flow and reflow resulted from BA and SA. During the fieldwork, we have been faced to users, like an old man who clearly explains this action:

> ...I have been a resident of Minoo since I was ten years old, and I perfectly remember that all of our agricultural lands were irrigated by streams until about 30 years ago. In some cases, the water could reach as much as two meters, which could easily irrigate the adjacent fields. (M, 65s, January 2019)

The river also provided boating services for both locals and tourists (*Figure 2*) which is not available now, in turn, cannot supply recreation services for visitors as before. A 55-year old woman who has been living in central part of island since 1970s, says:

> ...40 years ago, my father was a farmer and worked in our farmland in central part of the island and he provided the water for irrigating his land through one of the central streams called "Imanieh" which is unutilized now. Unfortunately, this river was desiccated after the war (F, 55s, August 2020)

Figure 2. Providing boating services by the BA before the war
Source: Ali Farnam

After the war, water salinity of streams as an important ecosystem disservice was increased by 300% during last two decades which in turn caused a large deterioration of farms' production and palm trees' dry out (ArmanshahrCompany, 2017). Therefore, the water flowing in island's streams is not drinkable and has been contaminated by waste disposal of homes and industries (*Figure 3*). Those streams which have been reconnected with BA, have salt water and cannot be used as drinking, washing or even irrigation. According to the municipal of the island as state:

> ...After the war and because of force disconnecting of streams from their originates, we observed a considerable population decline due to the lack of irrigation and fresh water supply systems in the island. People had to build their own tanks to preserve water near their homes which was expensive and made the water polluted. (M, 49s, January 2019)

Figure 3. Dominant status of local streams in Minoo island, Abadan
Source: taken by the author

BA which once considered to be the main source of seafood for islanders, is unusable today due to the national security issues after war which in turn has increased the migration rate over the last years due to the disappearance of thousands of agricultural jobs. The majority of farmers had to migrate to other adjacent cities such as Khoramshahr or Abadan to find a secure job detached-house alternative in light of their non-cultivable agricultural lands resulting in population decline. Consequently, this region was affected by ageing and the average age of Minoo residents rose to 45 years in 2014 (Statistical·Center·of·Iran, 2014). In this respect, one of the officials of AFZ states:

> ...The number of fishing pools in inner parts of the island is growing due to the uselessness of big and small arvand rivers of the island. This illegal action has polluted the environment of the Minoo and must be banned by AFZ. (M, 40s, August 2020)

Minoo's inner streams also provided fish provision due to their safe water which are not secure today as previously indicated.
In light of streams being fade during last years, Minoo's inhabitants had have the most physical contact with the SA in the north of island (*Figure 4*). This river provided socio-cultural services, including: swimming, limited fishing, civic spaces, pleasant views of natural environment and having a picnic.

Figure 4. An overview from SA, Minoo island
Source: taken by the author

In this respect, since this river is located in the northern line of Minoo, it was largely used as a recreational place for visitors and tourists coming from other cities. *Table 4* shows key blue infrastructure ESs/EDSs related to Minoo Island and their effects in causing urban shrinkage.

Table 4. Ecosystem services and disservices relevant in blue infrastructure of Minoo

ES/EDS Categories	ES before the war (1980s)	EDS after the war (1980s)	How it causes shrinkage
Provisioning	- Food supply based on fishing industry - Natural irrigation based on tidal mechanism - Freshwater supply	- Disappearance of fishing industry - Decrease in water quality (saline water) - Damage to farmlands due to internal rivers blockage	
Regulating	- Water flow regulation and runoff mitigation	- Bacteria and Virus in polluted streams	- Reduction of fishing-related jobs and consequently population out migration - Decrease in the number of visitors according to CFZ's report (2018)
Supporting	- Aquatic biodiversity	- Present of weeds, pests or mosquitoes considered	
Cultural	- Pleasant views of the rivers - Ecotourism industry - Water-related sports and recreational activities such as swimming, boating	- View blockage to Big Arvand river due to the southern embankment - Unpleasant for recreation due to sloughy streams - Algal blooms spoiling water courses for sport fishing or water sports - Restricted use of Big Arvand river	

4.2 Green services/disservices

In Minoo island and in particular periods about 40 years ago, food supply in relation to date and fish from palms and rivers, respectively, played an important role for food security, especially during economic and political crises after the war (*Figure 5*).

Figure 5. Picking dates by local residents in Minoo island before the war
Source: Arvan Free Zone Organization

Additionally, the diversity and density of palm trees as well as water-filled streams before the war had led to strong relationships between the previous inhabitants and ecosystems across the island. This had provisioning services as primary food production accounts for the majority of Minoo's output, with agriculture, fishing and date industry in the 1970s (ArmanshahrCompany, 2017) which are not available now and can be marked as one of the important drivers of shrinkage in this island. Forty years ago, 60 different types of dates were planted in this island which was recognized as main source of resident's income and food production. This matter was emphasized by several participants:

> Given the presence of healthy and dense palm trees in Minoo before the war, the islands' main economy was based on the production, supply and sale of dates. This is no longer the case today due to the frequent drying of trees. (Administrator Municipality of Minoo, February 2019).

Canebrakes are marked as both ES and EDS in Minoo. Firstly, the island's dwellers are unsatisfied with southern dense canes and try to fire them in order to prevent attacking wild hogs and other wildlife that hide behind between canes (*Figure 6*). In this case, canebrakes are considered as ecosystem disservices because they indirectly help kill dozens of islanders specifically children annually. One participant expresses negative feelings about the canebrakes:

Every resident in Minoo has unpleasant sense about the dense southern canebrakes where the wild animals hide and attack the people of the island. (F., 38s, February 2019)

Figure 6. Widespread canebrakes in south of Minoo island, Abadan
Source: taken by the author

Sugarcanes in Minoo have also regulatory service in relation to the flood mitigation which may be happens in BA. The densely 300-width and 9000m-length cane belt covered alongside the south of island has reduced the flood risk over the last decades according to the report published by National Organization of Environmental Conservation (2010). Moreover, as studies have suggested the use of canes for water and soil filtration due to their phytoremediation character (Wang et al., 2017), they are used for reducing farmlands' contamination in south of the island. The sugarcanes are also a source of sugar provision. The socio-cultural ES of canes are their utilizations for construction of Mozif which is a vernacular public or private building where is used for recreational, leisure, or educational activities (*Figure 7*).

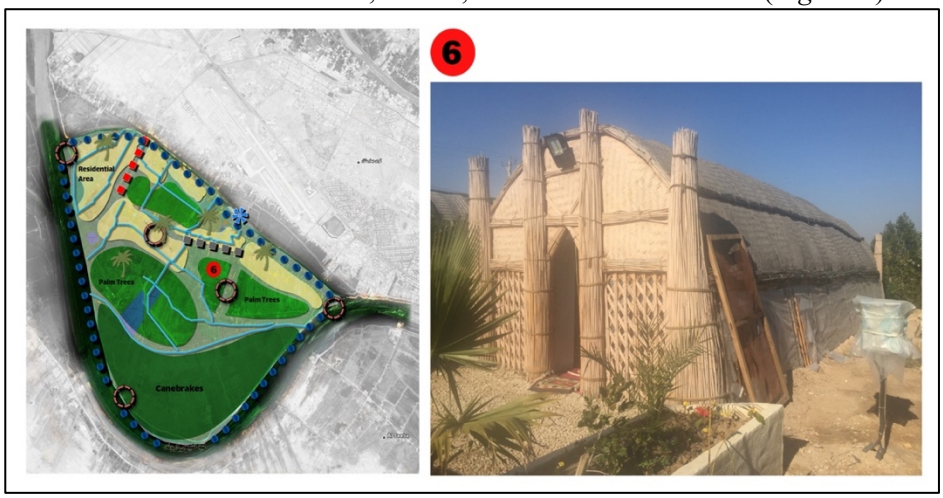

Figure 7. Mozif as a vernacular building type for civic activities
Source: taken by the Morteza Zameni

Before the war, the majority of palms were generally used as regulatory services for moderating micro-climate. Now, they are often used as planting potatoes or some daily vegetables under their canopies which were assumed to improve the quality of life according to several studies (Gómez et al., 2011; EC-European·Commission, 2013; Haase, D. et al., 2014; Mathey et al., 2015). Parts of palms were mainly used for producing timbers according to note from an AFZ's official (*Figure 8*). In the past, Minoo Island was characterized by this natural scene in pictures and websites (*Figure 9*). Visitors preferred to scramble under the palm trees due to the shading presence at the weekends. A

few healthy palms of this region currently produce date as well. One participant expresses her feelings about the pleasant scenes of the island before the war:

> We had a very lively island as the Iranian people traveled here on holiday. The main reason for the vitality here was the presence of large and beautiful palm trees and rivers. The islanders were fishing and picking dates on a daily basis. (F., 70s, January 2019)

*Figure 8***.** Burnt palm trees in Minoo island, Abadan
Source: taken by the author

Figure 9. Healthy palm trees before the war in Minoo
Source: Ali Farnam

Another important part of the island had been agricultural fields. As mentioned before, agricultural lands have played an important role in providing food for the island, but unfortunately, these lands gradually became vacant and unused with the outbreak of the war. Although these lands have great potentials for greening, the current environmental conditions of the island specially regarding the clean water provisioning for farmlands is not suitable. So, a substantial part of South of island is fully marked by vacant lands covered by dusts due to the deterioration of palm trees and farmlands (*Figure 10*).

In addition, in recent years, strong winds have caused enormous sandstorms which has resulted in increasing out-migration rates. They prefer to migrate from the island to greener areas like Khoramshahr. By contrast, the large 700-acre vacant area in the south of island is beneficial for absorbing stormwater rooted in BA. This area is also a habitat for migratory birds such as flamingos, storks and ducks. *Table 5* presents ecosystem services and disservices relevant in green infrastructure of Minoo.

Figure 10. Comparison of southern lands of Island before (Vaz et al.) and after (bottom) the war Source: Ali Farnam and the author

Table 5. Ecosystem services and disservices relevant in green infrastructure of Minoo

ES/EDS categories	ES before the war (1980s)	EDS after the war (1980s)	How it causes shrinkage
Provisioning	- Food supply by palm trees - Timber, date sap provided by palm trees	- Downturn in agriculture and date supply - Loss of date sap due to decaying	
Regulating	- Air purification - Urban trees provided shade - Soil cohesion - Nutritious soil for agriculture - Flood and storm buffering by dense palms barriers in the south; heat absorption during severe heat waves; intact wetland areas buffer river flooding - Air temperature regulation by dense urban trees	- Saline soil - Fire-prone dried palms Dried palms considered unpleasant by people - Damage to farmlands	- Decrease in the number of visitors according to CFZ's report (2018) - Increase in the number of farmers and farmlands according to the field study (2017-2018)
Supporting	- UGS provided habitat for birds	- Migration of birds - Direct attacks by wild animals due to dense canebrakes	

Cultural	- Pleasant views - Stronger religious activities - Palm climbing for picking date - UGS provided opportunities for relaxation and recreation - Ecotourism	- Lack of safe open spaces - Break up of dried palms falling in roads and lands and damage to people - Emerging unsafe vacant lands - Fear of getting lost in dark and dense canebrakes in night-time

5. DISCUSSION

This paper has shown that there are a wide variety of ES/EDS in Minoo in relation to blue and green spaces. If these potentials are to be preserved and exploited to aid sustainable urban development, they must be anchored into urban planning process and decisions. In the following section discusses planning and design strategies on island scale that take sufficient account of green-oriented planning and their ES.

5.1 Revitalization strategies for Minoo Island

The seriousness of Minoo decline in recent decades has prompted the local government to find planning solution to cope. There is a considerable potential for island-wide urban-greening strategy according to its previous healthy and active ecosystem. After deep analysis of environmental and social data, a green-oriented planning approach for revitalizing Minoo was proposed.

At the end of 2017, the Arvand Free Zone Organization boosted the procedure for designing and approving a new Master Plan, based on the idea of achieving a more sustainable future for Minoo Island as a shrinking region. This new Master Plan was prepared between 2017 and 2019 in Armanshahr private Company, an urban design consulting engineers in Tehran where the author is co-founder of the company and responsible for the project. Revitalization strategies for ES included four major strategies according to each four categories of ES. These strategies have been summarized in *Table 6* and can be visualized in *Figure 11*.

Table 6. Green-oriented strategies for Minoo Island

Type of ES	Proposed green-oriented strategy
Provisioning services	1)Designing big and small riverfronts, 2) protecting and maintaining of healthy palm trees, and 3) defining stream network
Regulating services	1) Greening of vacant lands and urban brownfields, and 2) connecting green corridors and patches
Cultural services	1) Enhancing palm trees and proposing new mixed nature-based land uses
Supporting services	1) Protecting the southern part of the island for future green developments and ecotourism activities, 2) installing a new subsurface drainage system in 700-acre area of Minoo in order to retention the nutrients of soil for cultivating new trees and vegetation.

Figure 11. A green revitalization plan was proposed according to ES/EDS approach in Minoo Island, Abadan city of Iran. (Source: drawn by the author and Armanshahr CO.)

5.2 Implications for future research

The present study reveals a range of ecosystem services and disservices for the first time in Minno, a small island in south of Iran based on a qualitative assessment approach which have less been applied in this line of research so far. The findings of this study support previous conclusions of other studies in a couple of ways. Firstly as some studies show, using community perceptions or perception-based assessments to analyze the ecosystem services is a strong tool especially for further sustainable urban planning and development strategies (Mahajan & Daw, 2016; Elwell et al., 2018; Ouko et al., 2018). Furthermore, the results also corroborates the assessment by Deka et al. (2018), which emphasizes on the role of man-made drivers of forest degradation and an analysis by Lawrence et al. (Lawrence et al., 2015) which shows the role of war and military activities on ecosystem degradation and population loss in a global scale. The respondents of the present study could share ecosystem services of the island over the previous decades as a reliable source of traditional local knowledge which can fill one of the most important research gaps reported by Balzan et al. (Balzan, Potschin-Young, & Haines-Young, 2018) in small islands like Minoo. The findings of this study regarding deep understandings of traditional residents about the role of palm trees and recreational activities of rivers which resulted in proposing protective strategies also matches with study of Cebrian-Piqueras et al. (Cebrián-Piqueras et al., 2020). Moreover, the unique role of forest and palm trees in ecological conservation of the system in the context of Minoo Island and probably similar tropical areas has been emphasized in other studies (Dislich et al., 2017).

6. CONCLUSIONS

This work is part of a greater Master Plan project in the Minoo Island which only presents ecological revitalization strategies. The results of this study reveals that the urban shrinkage in Minoo Island is closely associated with increasing EDS after the Iran-Iraq war in 1990s. This paper also shows that despite remarkable ecosystem potentials and functionalities in Minoo Island, it suffers from detrimental effects of ecosystem disservices leading to population decline over the past decades. Also, the degradation of stream system, palm trees, agricultural fields and expansion of vacant lands in Minoo undermine the quality of life of people which in turn, resulted in accelerating urban decline.

The major contribution of this study is using a mixed methodology of integrated analysis of ecosystem services and disservices for urban planning and design of shrinking cities in small islands. This approach is applied in this study in order to simultaneously assess negative and positive outcomes of ecological assets in order to support decision makers for creating a balance between those strengths that are crucial for urban development and those weaknesses which are causing urban decline in Minoo Island. In this process, communicating stakeholders, whose lives and interests are affected by the organization imposed by the plan, had a considerable impression on team. This research provides important lessons to other similar shrinking cities and urban planners designing revitalization programs at a large scale. Some urban-greening strategies such as ecological protection in approximately southern part of the island, all inner river restoration and stablishing new UGI in farmlands, derelict spaces and brownfields are proposed for coping with shrinkage in Minoo which are categorized as green-oriented planning or nature-based solutions approaches. As a final conclusion, the Minoo Island and similar cases must consider revitalization of ecological functions in relation to their natural assets such as streams, trees, rivers and vacant lands.

Although this paper improves researchers' understanding of analytical ES/EDS approach in urban shrinkage, further researches on different cases and quantitative analysis of ES/EDS (e.g. air regulation, greenhouse gas flux, stormwater runoff reduction, and soil nutrient) is needed to acquire comparable findings. For planners and urban designers, the approach may also serve as a decision support tool, e.g., in order to propose ecosystem-based transformative, adaptive and conservative planning policies with respect to mitigate urban decline. Research on urban planning and design of shrinking cities should expand its present domain on ecosystem-based and socio-ecological dynamics and measurements to better articulate all sustainability values in decision making. Another limitation of this study is that the different respondents' socio-economic status which may affect the cultural aspect of ES in small islands are not included which should be taken into account in future studies.

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APPENDIX 1.

The questions included in the survey interview

I. How long do you live in Minoo Island?

……

II. What have been the most important environmental and tourist potentials of the island in the past?

……

III. Which site do you think has had the most potential to deliver the ecosystem services that you value?

……..

IV. Do the palms in the island still play a role in your daily work and livelihood?

……..

V. Why the island's population declined over the past decades?

……..

VI. What role did the island's rivers play in your everyday life in the past?

……..

VII. What role do the island's rivers play in your everyday life currently?

……..

VIII. What is your opinion about the widespread canebrakes in the island? Are they harmful or useful? Why?

……..

IX. What are the main drivers causing changes in the Minoo's ecosystems and their services and disservices?

……..

X. How did ecosystem services affect human well-being of residents in the past?

……..