EREM 78/2
Journal of Environmental Research, Engineering and Management
Vol. 78 / No. 2 / 2022
pp. 100–117
DOI 10.5755/j01.erem.78.2.30421

An Ecosystem-Enriched (EDPSEEA) Methodology for Sustainable Urban Development of Communities in Egypt

Received 2021/12 | Accepted after revision 2022/04

http://dx.doi.org/10.5755/j01.erem.78.2.30421

An Ecosystem-Enriched (EDPSEEA) Methodology for Sustainable Urban Development of Communities in Egypt

Yomna Hesham
Environmental Planning Department, Faculty of Urban and Regional Planning, Cairo University, Cairo University Campus, Gamaa Street, Giza, Egypt.

Ahmed Yousry
Department of Urban Planning, Faculty of Regional and Urban Planning, Cairo University, Egypt.

Nada Saleh, Seham Mostafa Qutb*
Environmental Planning Department, Faculty of Urban and Regional Planning, Cairo University, Cairo University Campus, Gamaa Street, Giza, Egypt.

***Corresponding author:** Seham.mostafa@cu.edu.eg

Despite efforts to achieve environmental sustainability, the globe is not yet on the right track; various difficulties have lately emerged because of development, including natural resource depletion, biodiversity loss, and pollution issues. The strategic objectives of the environment for the year 2030 aim to achieve rational management of natural resource assets and the maintenance of the balance of ecosystems and biodiversity, and hence, it is necessary to deal with the important challenges of current urban development, which directly and indirectly affect resources and ecosystems, and human health. This has led to development of tools to consider the relationship between human activities and environmental sustainability in a policy-relevant way. Such tools can identify policies that might simultaneously achieve sustainability, preserve resources while protecting health and equity. This paper aims at understanding the impact of various urban development sectors on environmental ecosystems through employing a systematic framework to formulate appropriate measures and policies to confront these challenges. Various methodological frameworks are reviewed leading to selection of the ecosystems-enriched **D**rivers, **P**ressures, **S**tate, **E**xposure, **E**ffect **A**ction (eDPSEEA) as an appropriate tool for assessing and determining the cause and effect of an ecosystem to guide and direct responses and actions in the Egyptian context. El Fayoum Governorate is selected as a case study to test the suitability of this framework.

The study concludes that the application of this systemic methodological approach can enhance understanding of the interrelationships among the multifaceted components within the urban system and its impacts on ecosystems, helping to enhance the decision-making and implementation processes.

Keywords: ecosystem-enriched (eDPSEEA), environmental health, ecosystem, urban development, environmental sustainability.

Introduction

The world has become increasingly civilized, so a set of environmental challenges has appeared. Urban areas now represent 50% of the world's population and consume up to about 75% of natural resources. This affects sensitive ecosystems and leads to the over-exploitation of resources (Dodman et al., 2013). As the world now knows, over the past few decades, the state of the global environment has become critical in many aspects, such as the depletion of natural resources, necessitating efforts to raise environmental consciousness to conserve such resources. The relationship between natural resource governance and the sustainable consumption and production of resources demands urgent consideration of the most important ways to activate and sustain the rational management of natural resources as a basis for achieving sustainable development (El-Sayed, 2017).

To develop actions that protect both ecosystems and human health and well-being in socially inclusive, sustainable, equitable, global, and cross-generational ways, tools and indicators are needed to work with that aim to reduce environmental impact, improve environmental conditions, and take steps to protect the environment (Morris et al., 2019; Bakumenko et al., 2015). Thus, the world has begun to develop a set of principles, frameworks, and tools that allow assessment of how far the environment has improved. These approaches and tools also allow the exploration and management of cross-linkages at a system level so that policies can effectively support several social, economic, and environmental goals to support human well-being (Ekins et al., 2019).

Since the last quarter of the twentieth century, Egypt has experienced significant expansion and utilization of its natural resources to meet the economic needs of a rapidly growing population. As a result, environmental challenges, including resource depletion both renewable and non-renewable, have become more widespread (Anwar, 2003). Accordingly, Egypt now faces several environmental challenges including pollution of the air, water, and land. Furthermore, this situation places extra stress on Egypt's limited natural resources, which, in turn, puts the urban environment under even more stress (Amen, 2021). Despite recent advancements, pollution continues to have negative influence on the local and national environment. And according to a World Bank investigation, the health repercussions of these influences is estimated to be 2.5% of Egypt's GDP in 2016–2017. (World Bank, 2017).

Fayoum Governorate is regarded as one of the most important Egyptian governorates due to its huge diversity of the natural environments. It is also a governorate rich in biodiversity containing globally classified environmental conservation areas, for example, Wadi El-Hitan and Wadi El-Rayan, as a critical location for maintaining sustainability in the migrations of rare birds (GOPP, 2021). As a result of directing some projects and strategies to them, the governorate may experience rapid urban growth processes, which have a direct impact on ecosystems. As a result, a set of conditions and measures must be put in place to ensure sustainable development while preserving natural resources.

Many scientific models now adopt a systems approach to describe and explain the synergies between the environment, human activities, and human health, to establish the links between society, the economy, the environment, health, and well-being, and to highlight the importance of biodiversity (Carmichael et al., 2017). Accordingly, the authors conducted a search for frameworks and tools which could aid understanding

of the relationship between development processes and environmental health to make the study area able to adapt and withstand the challenges and dynamic conditions brought about by pressures in multiple sectors.

The authors identify the ecosystem-enriched **D**rivers, **P**ressures, **S**tate, **E**xposure **A**ctions (eDPSEEA) framework as an innovative tool which can be applied to promote better management. In particular, the model is suited to exploring the dynamic links between the different driving forces and pressures related to the development process and human changes that significantly affect ecosystems and the services these provide. It also supports development of a set of indicators to enable quantification of the health impacts and the effects of policy actions on so-called "environmental stressors". The model is distinguished by a capacity to represent the effects of environmental change on health and wellbeing through a proximal (in space or time) pathway or through ostensibly more "distal" ecosystem changes. It recognizes, too, that the human (social) environment is closely related to the environment natural and indirect dynamic interaction with it (Andrews, 2014; Briggs, 2008).

The significance of this research lies in the application of an interlocking approach that aims to understand the causal and root relationships for pressures with proposing a set of mechanisms appropriate to the Egyptian situation in terms of its ability to withstand crises and challenges which make it more sustainable for all sectors. The research is structured according to the following sequence:

- determining the proposed appropriate tool for analyzing the Egyptian governorates;
- applying that tool in the Egyptian case to analyze the current situation and evaluate its state to improve the environmental performance of that governorate.

Research Aim

The research aims to improve the relationship between the natural environment and human activities in Egyptian governorates. Specifically, by understanding the relationship between urban development and the impact on ecosystems and human health (and by applying the appropriate tools and approaches to analyze the current situation using the components of the eDPSEEA model), it is hoped to arrive at an understanding of mutual impacts and enhance the ability to withstand the problems of urban development in all its dimensions: urban, environmental, economic, social, etc. In this study, it is recommended using a framework and appropriate action tools in the case of Egyptian governorates by first understanding the nature of the Egyptian situation and then conducting a questionnaire survey of relevant experts to refine that understanding and identify ways to mitigate the challenges. The approach is then applied to Fayoum Governorate – an area of importance due to its unique nature (environmentally and geographically), within which eco-tourism, agriculture, and industry are all used to improve the quality of life of its residents within an environmentally and socially compatible urban system. All these factors have made Fayoum Governorate a critical governorate for preserving the natural environment (GOPP, 2014).

Global environmental frameworks to improve the relationship between the natural environment and human activities

Motivated by the multiple contemporary environmental challenges, many international organizations have tended to create and develop models that work on understanding the relationship between human activities, the physical environment, and health, and how procedures and policies affect those challenges. *Fig. 1* shows the sequence of development of models based on the original DPSEEA framework (Reference). *Table 1* provides additional detail on this "family" of models, their component elements, and the purpose of each model.

The World Health Organization (WHO) originally introduced the DPSEEA (Driving forces-Pressure-State-Exposure-Effect-Action) model as a framework to develop guidelines on environmental indicators (Lam et al., 2014), specifically, to support decision-making to reduce the burden by describing problems from their root causes to the impact on the environment, ecosystems, and human health (Hambling et al., 2011).

Fig. 1. *Evolution of global frameworks to improve the relationship between the natural environment and human activities (Source: Morris et al., 2017; Morris et al., 2019; Van der Vliet et al., 2018)*

Table 1. *DPSEEA framework family*

Framework	DPSEEA	Modified DPSEEA (mDPSEEA)	Ecosystem-enriched (eDPSEEA)
Elements	A simple linear path to environmental health consisting of Driving force- Pressure-State-Exposure-Effect-Actions).	Driving force-Pressure-State-Exposure-Effect-Actions With a focus on the importance of context and the many characteristics of each region in exposure and its various impacts.	Driving force-Pressure-State-Exposure-Effect-Actions Integrating ecological and ecological health considerations with human health and well-being and the activities that it undertakes.
Organization	The World Health Organization (WHO).	George Paterson Morris et al (Morris et al., 2006).	Stefan Reis et al (Reis, et al., 2015).
Year	1992	2006	2015
Aim	Supporting decision-making to lessen the burden by describing problems from their underlying causes to their environmental and human health impacts. (Hambling, 2011).	Its goal is to create a more effective model for the challenges and allow the model to be applied at various geographic and administrative levels.	Its goal is to comprehend the effect of direct and indirect environmental pressures on human health, well-being, and the health of ecosystems and thus assess human health and ecosystem as two sides of the same coin (Reis, et al., 2015).

The model provides a descriptive representation of how different driving forces generate pressures that affect the state of the environment and, ultimately, human health through the many exposure pathways through which humans interact with the environment (Von Schirnding, 2002).

The modified DPSEEA (mDPSEEA) model (modified Driving forces-Pressure-State-Exposure-Effect-Action) was established in 2006 to develop a new policy approach to the environment that is more effective to the contemporary environment and health policy challenges. The mDPSEEA model differs from the original model by incorporating a set of contextual factors that may influence whether an environmental state (positive or negative) translates to an exposure (positive or negative) to an aspect of the environment and an often-separate set of contextual factors which determine whether an individual experiences a health effect (positive or negative). In short, the interaction of contextual factors can profoundly influence individual risk and has an important bearing on equity. These contextual factors may include geographical, social, economic, and behavioral influences, i.e., placing exposure and influence within a specific context

(economic, social, etc.) to allow it to be applied at different levels where the characteristics and nature of each geographical area differ from the other (Morris et al., 2017; Morris et al., 2006).

The ecosystem-enriched (eDPSEEA) model was developed in 2015 to show how environmental health must, today, address both proximal environmental determinants of health and well-being, but also the human health and equity effects of anthropogenic damage to ecosystems. It achieves this by representing two pathways within the model – a proximal pathway which is concerned with environmental impacts on health in the "here and now", and distal issues which explicitly link multiple (primarily anthropogenic) drivers of ecosystem change to human health through their impact on ecosystem services (the benefits that humans derive from the environment). These ecosystem changes and their implications are often conceptually more distal to the population in any location (these might extend from quite local ecosystem changes to the impacts which a local population might have on the Earth's ecosystems and the ecosystem services that they provide). By explicitly linking ecosystem services to human health and well-being, eDPSEEA seeks to integrate considerations of ecosystem health and the environment with human health, well-being, and activities in accordance with the main idea of environmental public health (EPH) (Andrews, 2014; Morris et al., 2019).

It is found from the analysis of the framework that all the pillars of these models emphasize the importance of understanding the relationship between human activities, the physical environment, and health, as well as the main relationship to the challenges facing the environment.

Choosing the appropriate analytical framework to apply to the Egyptian case

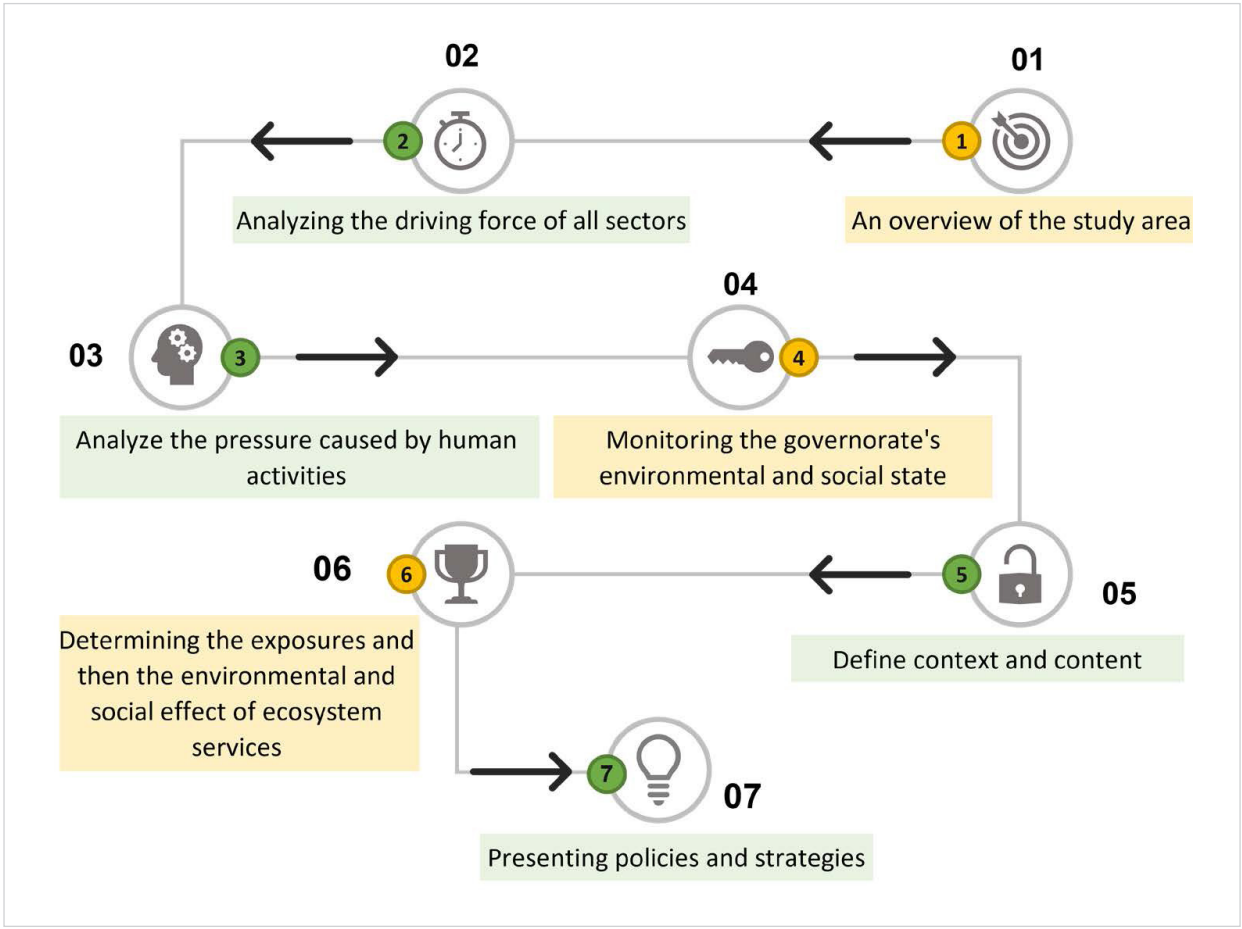
Understanding the nature of the Egyptian situation, as well as conducting a questionnaire survey for experts concerned with enhancing the link between the natural environment and human activities, led to the selection of the appropriate framework. The ecosystem-enriched framework (eDPSEEA) was chosen because it considers the interaction between ecosystems and environmental health, as well as the direct and indirect effects of various urban development processes on human health (Morris et al., 2017).

It works for a few purposes: as a conceptual framework for understanding the problem and deduction; as a scientific tool for understanding and predicting the complex interactions between man, environment, and ecosystem; as a tool to guide management and make policy decisions and responses; as a communication tool to interact with stakeholders (Reis, et al., 2015).

Therefore, eDPSEEA is appropriate for the Egyptian case, as it contains a variety of ecosystems that suffer from deterioration because of development processes. The eDPSEEA is applied to Fayoum Governorate to understand the relationships between development processes and the direct impact on ecosystems and human health. Through such an understanding, environmental performances can be improved by developing a set of strategies that fully describe the needs of Fayoum Governorate to preserve its ecosystems and may also help achieve sustainable urban development in other Egyptian governorates. The process is done through the following steps:

- introducing the study area;
- analysis of the driving force in all sectors;
- analysis of the pressures resulting from human activities associated with each of the ecosystems and their services, as well as on the natural environment and ecosystems;
- monitoring the environmental and social status of the governorate, as well as the ecosystems and their services;
- determining the context and content that affect the governorate;
- determining the exposures and then the environmental and social impacts of environmental services on preservation, as well as on environmental and human health;
- providing policies and strategies to support the sustainable consumption of resources and the preservation of ecosystems and their services in the governorate.

Fig. 2. *The (eDPSEEA) framework's implementation steps (Source: authors)*



The ecosystem-enriched eDPSEEA framework used in Fayoum Governorate

An overview of the study area

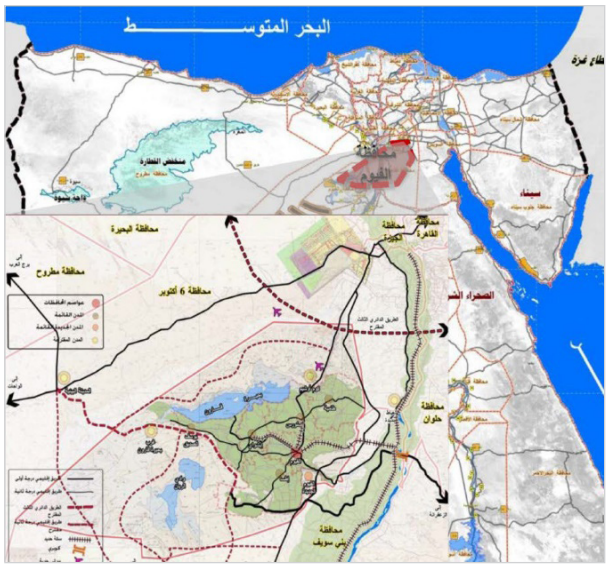
Fayoum is one of the governorates of North Upper Egypt, next to the governorates of Beni Suef and Minya. Fayoum governorate extends between latitudes 29° 00 and 29° 40 north and longitudes 29° 50° and 31° 10° east. Fayoum Governorate extends on its borders with Giza Governorate (from the north and west sides) and Beni Suef Governorate (from the east and south sides), as shown in *Fig. 3*. Its area is about 6068 km^2 (1.44 million acres), and the total population of Fayoum Governorate was 3.8 million in 2020 (GOPP, 2020; Citizen Plan for 20/2021) Fayoum is characterized by its unique environment, which differs from that of the Delta and Upper Egypt, where the ecosystems range from agricultural to desert and lakes. It has been endowed by God with natural beauty and a mild environment all year. It is a valley, a delta, and a lake all rolled into one.

Identification of the framework used

In this part of the research, the framework that was chosen to analyze the interconnected relationships in Fayoum governorate is identified, where this tool consists of six basic stages represented in "Driving force–Pressures–State–Exposure–Effect–Action," but this performance is divided into two main paths that began with the pressures. As driving forces create pressures that change characteristics associated with the environmental state near or proximal to the

community, each pathway has its property. However, it also reflects a different set of driving forces for the community's health and well-being. This is called the distal path (Morris et al., 2019). As the driving force, it is the factor influencing the development process through human activity in all sectors (social, economic, political, technological, etc.), which may exert direct (proximal) or unintended impacts on the environment (the distal path). This, in turn, has an impact on human health as well as the achievement of sustainability in all its areas (Morris, 2013; Morris, 2015), as shown in *Fig. 4*.

Fig. 3. *Location of the Governorate of Fayoum (Source: authors)*



First stage: the application of the elements of the framework in Fayoum Governorate

The framework will be used in Fayoum Governorate at this stage by applying each part of the framework separately and providing the indicators within those elements in more detail.

Driving forces

The driving force is represented in economic growth, population increase, urban development, regional and national future trends, and it has a significant impact on many areas of the natural environment and ecosystems, as well as human health (Briggs, 2008; Von Schirnding, 2002). The following is an overview of the governorate of Fayou's driving forces.

Fig. 4. *The eDPSEEA framework (Source: Morris et al., 2019)*

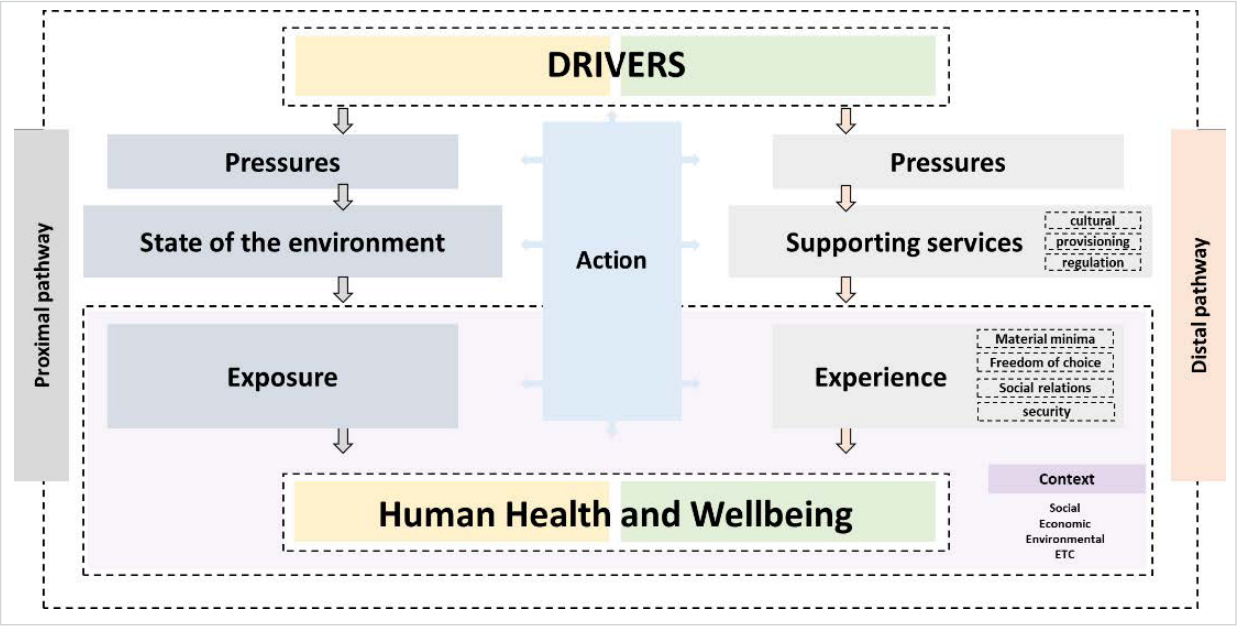


Fig. 5. *Driving forces (Source: authors)*

Table 2. *Driving forces of El-Fayoum Governorate (Source: authors)*

Urban development	Tourism development	Economic	Policies
Because of the state's involvement in the development of Fayoum Governorate and the proposal to turn it into a comprehensive economic, social, and urban development pole, the governorate can play an integrated role in all activities and has an impact on urban and social development (GOPP, 2017), as well as the governorate's relative importance due to its environmental and geographical uniqueness (GOPP, 2017; GOPP, 2016).	Given the variety of environments in the governorate and the diversity of its tourism product, it has been proposed that Fayoum governorate become a liaison governorate for the tourism movement through tourism integration and linking between surrounding tourist sites by establishing a vision to make it an attractive destination for the global, Arab, and local tourism movements through a set of internal and external paths (GOPP, 2017).	The governorate's economic function is also crucial, as a set of projects influencing the economy and tourism were directed, as follows: projects for the governorate's economic growth (GOPP, 2017); proposing new industrial projects to Raise efficiency the city's role; a portion of Kom Oshim Airport will be converted from a military to a civilian airport; A road to the south of the governorate is suggested.	The political role is also one of the factors affecting the driving force, which is represented in Fayoum Governorate, as it is the gateway to the Western Desert and Bahariya Oasis (GOPP, 2014). This gives it importance where nature and the possibility of integration with ecotourism and the Wadi Al-Hitan Reserve have been designated as a green area by the International Union for Conservation of Nature.

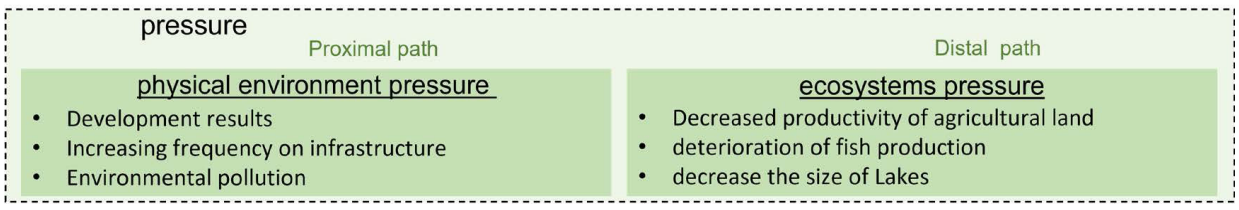
Urbanization

The process of urbanization in Fayoum Governorate appears in development trends directed to it, which leads to an increase in demand and pressure on internal resources. As Fayoum Governorate is one of the most important governorates with natural resources, as seen in the last recent years, many trends and recommendations were offered to play an important economic and tourist role for the Arab Republic of Egypt.

Pressure

The pressures are caused by the previous driving force and human activities, as it acts as a catalyst for environmental pressure in the form of a production, consumption, waste generation, etc. (Morris et al., 2019). Ecosystem stresses are transferred and turned into a range of natural processes, to show the changes in environmental conditions (Le Anh, et al., 2020; Von Schirnding, 2002). The pressures are separated

Fig. 6. *Pressure (Source: authors)*



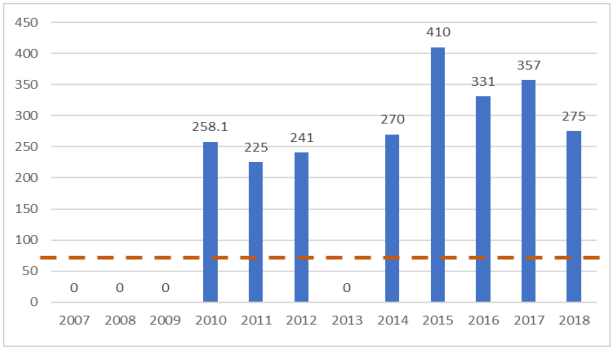
into two paths: the proximal path, which is represented by pressures on the physical environment and on which the effect emerges immediately, and the distal path, which is represented by pressures on ecosystems and on which the effect appears after some time. The following is a breakdown of the pressures in the governorate of Fayoum on both paths.

Proximal path

Physical environmental pressure

Several challenges have recently emerged in the context of the government's efforts to bring about development in all sectors, represented in the continuous pressures on environmental resources because of development process and human activities, which appear as a direct impact through the proximal path, which shows some changes in the environment during the current time and place (Van der Vliet et al., 2018). The governorate's urban development process is represented in industrial, tourism, and agricultural activities because the governorate has resources capable of establishing all sectors; however, there is an unfair encroachment on mineral resources in the governorate through the exploitation of all resources in the proposed industries (Mustafa et al., 2009). Furthermore, these activities have resulted in a significant percentage of pollutants and trash as a result of extraction and manufacturing procedures for raw materials, as evidenced by total suspended particles exceeding the allowable limit of 90 μg/m^3 as shown in *Fig. 7*, which amounted to 410 μg/m^3 in 2015, and became 275 μg/m^3 in 2018, but it still exceeds the allowable limit. This mainly affects the ecosystem as well as human health (CAPMAS, 2020).

Fig. 7. *Total suspended particles (TSP) (μg/m3) (Source: CAPMAS, 2020)*



Distal path

Ecosystem's pressure

The distal path shows long-term changes and pressures, as well as the indirect impact on ecosystems and ecosystem services, which has an impact on

Table 3. *Ecosystem's pressure (Source: authors)*

Distal Path	
As a result of agricultural activities and high rates of agricultural drainage in the governorate, the degree of salinity of agricultural lands increased, affecting agricultural production as 70% of the lands became third and fourth-degree salinity and the surface area of agricultural lands decreased as an ecosystem (GOPP, 2017; Gad EL-Rab, 2008).	The governorate's increased agricultural and industrial drainage rates caused the proportion of salt in the lakes to rise to 42 grams per liter, resulting in a decline in fish productivity in Lake Qarun, where 12 species of fish were observed, some of which became extinct, and there were only saltwater fish left because of the high saltiness, as well as the illegal fishing and other factors (CAPMAS, 2020; Baghdadi, 2017).

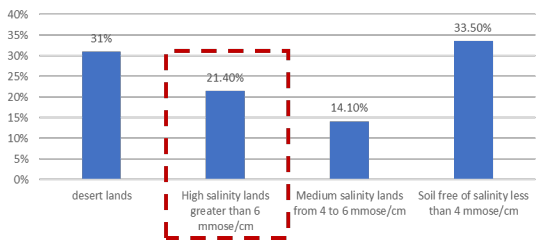
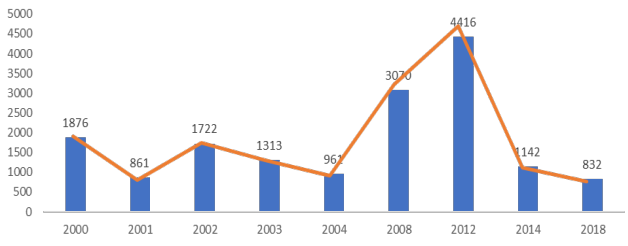

	

Fig. 8. *Salinity rate of agricultural land (Gad EL-Rab, 2008)*	**Fig. 9.** *Lake Qarun's fish production (CAPMAS, 2020)*

human health (Van der Vliet et al., 2018). The following is an overview of the pressures on Fayoum Governorate's distant path ecosystems.

Not only the pressure on the ecosystems is the result of development processes alone, but also natural hazards as well. The lakes in Fayoum Governorate are exposed to the danger of dunes at a rate of encroachment of 2.15 meters per year in the direction of northeast and southwest of Wadi El Rayan and northeast of Lake Qarun, which led to a shrinkage in the size of lakes and filling a group of springs in Wadi Al Rayan, where the size of the lakes of Wadi Al Rayan varied in the years 1984, 2010, and 2021 being 96.26 km^2, 94.96 km^2, 72.21 km^2, respectively, as well as Lake Qarun being 243.56 km^2, 242.11 km^2, 236.70 km^2, respectively, also as shown in the *Fig. 10* and *Table 4* (Gad EL-Rab, 2008; Baghdadi, 2017).

Table 4. *Lakes sizes (Source: authors based on google earth satellite)*

Lake \ Year	1984	2010	2021
Wadi Al Rayan	96.26	94.96	72.21
Lake Qarun	243.56	242.11	236.70

State

The state of the environment is represented by changes caused by pressures on the natural and urban environment, as well as human activities such as (environmental pollution or increased risks, etc.), and the case is also divided. The proximal path, which indicates the direct impact on the natural environment, and the distal path, which shows the impact on ecosystems, are represented in the ecosystem services as follows in the Governorate of Fayoum (Le Anh, et al., 2020).

Proximal path

The proximal path of indicators of the environmental condition in Fayoum Governorate consists of current activities, development processes, and the resulting pollutants, as well as the governorate's social status, which plays a vital effect on the environmental condition, are the indicators of the state of the environment in Fayoum Governorate.

Distal path

The framework draws on Millennium Ecosystem Assessment insights to link ecosystem damage to

Fig. 10. *Shrinking lake sizes (Source:authors based on google earth satellite)*

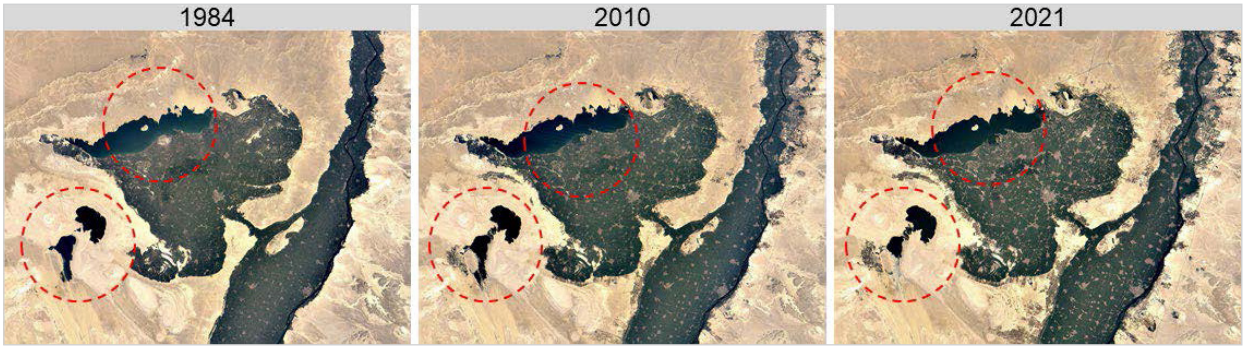


Fig. 11. *State (Source: authors)*

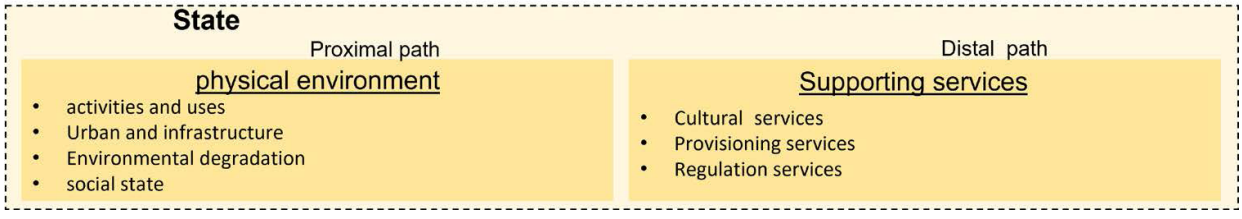


Table 5. *Proximal Path of state (Source: authors)*

Proximal path		
Fayoum governorate has a unique natural environment, with desert systems accounting for 16% of the governorate's entire area, the lake's system accounting for 8% of the governorate's total area, and the agricultural system accounting for 36% of the governorate's total area (IDSC, 2021).	The governorate's development processes cause an imbalance in the environmental balance, with agricultural activity accounting for 44% of total activities in the governorate, followed by industrial activity accounting for 21% of total activities in the governorate (GOPP, 2017).	The governorate's social situation has an impact on the environment, with a 34% illiteracy rate compared with the Republic's average of 25.8%, and a population density of 159 people per acre compared with the region's average of 122 people per acre, as well as 71.27% of the population, lacking sanitation services (CAPMAS, 2020; Ministry of Local Development, 2021).
	This results in a collection of pollutants from agricultural and industrial drainage being dumped into lakes at a rate of 350 million cubic meters per year (Baghdadi, 2017).	
	And there is a range of economic resources in the governorate, and there is a spare, but most of these resources are located in or near nature reserves, which has an impact on ecosystems when extracted (Gad EL-Rab, 2008).	

human health and well-being by considering its impact on ecosystem services. Ecosystem services are the benefits that humans receive from the natural environment and are expressed in terms of supply services, regulatory services, and cultural services, all supported by supporting services (Morris et al., 2017). The following is a summary of Fayoum Governorate's ecosystem services. Ecosystem services are the indirect and direct benefits that humans derive from the ecosystem to survive and improve their quality of life (Von Schirnding, 2002).

Supply services (productive value)

Supply services are a collection of elements that assist the production of all types of food.

Regulatory service

Ecosystems supply numerous essential functions that make people's lives possible, hence regulatory services are critical.

Table 7. *Regulatory service (Source: authors)*

Water regulation	The governorate has no water regulation sources, although it does have various water sources from the Nile River's lakes and tributaries.
Natural hazards	The governorate's natural hazards are represented by the sand dunes, which are growing at a pace of 15.2 meters per year (Gad EL-Rab, 2008).

Table 6. *Supply services (Source: authors)*

The nutritional value of agricultural and livestock production	Fish production in farms is 23 327 tonnes, Lake Qarun is 832 tonnes, and the Wadi El-Rayan is 6295 tonnes (CAPMAS,2020), in addition to the agricultural production, as 27.6% of the lands in the governorate are agricultural lands (CAPMAS, 2020). It also produces 39 972.45 million tonnes of red meat and 14 228 million tonnes of white meat per year (CAPMAS, 2020).
Fresh water	The Nile River and its tributaries, which are represented by Bahr Youssef Canal, Bahr Hassan, and seasonal rainwater water, provide fresh water to the governorate in the amount of 289 323 thousand m^3 every year (CAPMAS, 2020).
Fuel and fiber	Oil wells located around Lake Qarun and Wadi El-Rayan, some of which produce about 3000 barrels per day, and the region's reserves are estimated to be around 5.6 million barrels. (CAPMAS, 2020)

Spiritual values

Spiritual values, aesthetic values, recreation, ecotourism, and education are examples of cultural services that a person might acquire from the ecosystem.

Table 8. *Spiritual values (Source: authors)*

Historical values	Temples, archaeological areas, and archaeological and historical tombs, such as the churches area of Qasr Qarun temple, Madinat Madi temple, Qasr El Sagha temple, Obelisk of Senusret Deir Al Arab, Serment Monastery, Hawara pyramid, Pyramid of Sila, Lahon pyramid.
Recreational values	Lakes and their beaches, as well as tourist hotels built around the lakes (the waterways area, sand dunes and mountain formations, valleys, and safari tourism, the eyes of Selin, the waterfalls area).
Aesthetic values	Attractive sand formations (the distinctly shaped Qatrani mountain, areas of bird migration paths, Furn al-Dhahab Island in the governorate, nature reserves and its components, Wadi Al-Hitan Reserve and its fossils, the many geographical features of sand dunes, mountains, and valleys).
Educational values	Locations where a scientific study can be undertaken (the areas of fossils, fossilized plants, and Al Rayyan as a site to maintain its sustainability, the migrations of rare birdlife, Wadi Al-Hitan Protectorate as the first Egyptian environmental site to join the World Natural Heritage List (GOPP, 2021).

Context

The context is contained within the framework. It is reflected in the elements that influence exposure as well as the consequences of environmental conditions. Socioeconomic, regional, and demographic considerations all play a role in the context (Morris, 2010; Morris et al., 2015).

The context affecting the governorate is represented by a set of the following factors: economic factors, social factors, geographical factors, behaviors, as shown in *Fig. 12*.

Fig. 12. *Context (Source: authors)*

This is accomplished through the following:

Economic factors: They are present in economic development and project development without regard to the environmental dimension, and they have a multiplicity of activities and uses that pollute the environment.

Social factors: Lack of equality in the availability of basic services (such as drinking water and sanitation) leads to a decrease in the quality of life in the governorate.

Behaviors are reflected in the population's lack of awareness of how to cope with environmental problems and challenges that arise as a result of development processes.

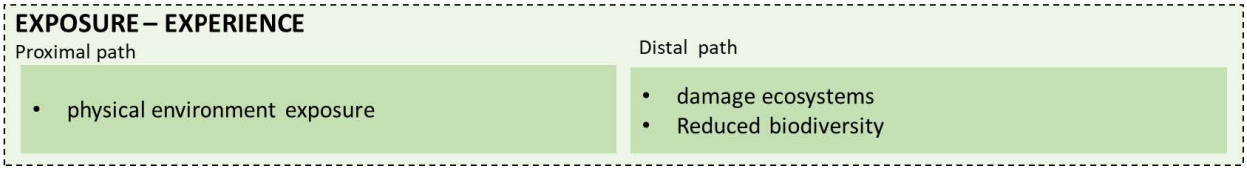
Geographical factors: They are represented in various geographical factors because of the governorate's diversity of habitats, while preserving the techniques of dealing with all of them as a single site, regardless of the uniqueness of each case.

As a result, these factors have an impact on the state of the environment, which can be seen in the governorate's environmental exposure and impacts. A summary of the governorate's exposures and influences is discussed later in the paper.

Exposure

When there is contact between humans and the environment with the presence of a pollutant or danger, exposure occurs. When it comes to environmental pollution, exposure can take many forms, and it is dependent not only on pollutants but also on societal conditions and other elements (Corvid et al., 2000). Exposure can be thought of as state change parameters (Le Anh et al., 2020). *Fig. 13.* shows the case for Fayoum Governorate.

Fig. 13. *Exposure (Source: authors)*



Proximal path

Exposures are represented in air, water, and terrestrial environmental pollutants as follows: 70% of the Fayoum governorate drains into lakes (agricultural drainage), causing the lakes' salinity to rise to 42 grams per liter (GOPP, 2014). Furthermore, agricultural lands have a high salinity level, as 21.4% of the lands are high salinity (Mustafa et al., 2009). As a result of industrial activity and trash, the percentages of air pollutants and total suspended particles are greater above the legal limit, reaching 404 mg/m^3 in the governorate (GOPP, 2017).

Distal path

Despite the governorate's diverse range of ecological systems and resources, it is deteriorating as a result of the changes in the environmental state and ecosystem services as well as pressure on them; the governorate's fish productivity has decreased by 75% as a result of these exposures, particularly in Lake Qarun (CAPMAS, 2020). In addition, the productive potential of agricultural lands has decreased, and 70% of lands have been graded 3–4 (GOPP, 2017). Besides, the lakes are shrinking in size as a result of sand dunes encroaching on them at a rate of 15.2 meters each year (Gad EL-Rab, 2008).

Effect (Health and Wellbeing)

Pollution and environmental dangers, in turn, cause a wide range of health impacts that vary in type, severity, exposure amount, and number of people exposed (Corvuldn et al., 2000). When a person is exposed to environmental danger, they may experience similar health impacts that vary in form, severity, and degree (Von Schirnding, 2002). The following is a list of the effects on human health in the governorate of Fayoum, as shown in *Fig. 14*.

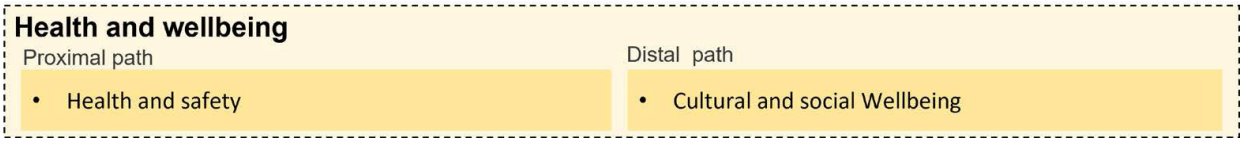
Proximal path

The impact on health in the governorate appeared through the population's exposure to diseases and pollutants affecting them, and it manifests in the governorate in the following ways (Environmental characterization Fayoum Governorate, 2008). As a result of the governorate's high rates of respiratory ailments, 600 people get infected each year because of the governorate's economic activity. And the governorate's high rates of kidney failure disorders have reached 21 554 people per year as a result of water and pesticide pollution. The governorate's high rates of cancer have reached 17 cases each year because of air pollution. In addition, the governorate has a high frequency of endemic diseases, with 28 551 people afflicted each year because of air pollution.

Distal Path

Human well-being is a high-value category that encompasses physical, emotional, and social well-being and is multifaceted and context-dependent. Many aspects service an environment like access to food and water.

Fig. 14. *Health and Wellbeing (Source: authors)*



From the above, it appears that the governorate suffers from a lack of access to luxury, as the governorate suffers from a lack of quality of life as a result of lack of connection to clean water and poor connectivity to sanitation services, as well as a lack of food quality and quantity, as well as air pollutants.

Action

As a result of environmental issues and evident health repercussions, actions are taken. These measures may be curative or preventive to eliminate or reduce environmental risks through risk management, as well as environmental improvements through mitigation, prevention, compensation, adaptation, or correction of changes in the state of the environment and human health (Von Schirnding, 2002; Le Anh, et al., 2020; Porche, 2004). The following is a summary overview of the measures taken by the Governorate of Fayoum.

Fayoum Governorate is facing continuous development processes that require an increase in resource consumption to keep pace with that development. Therefore, it is exposed to various pressures, mainly represented in the consumption of resources. Environmental pressures are also affected by the context and human behavior of the population of the governorate, and the ecosystem can bear these pressures to a large extent, but once these pressures are exceeded, this will lead to damaging the state of the environment as well as the state of the ecosystems, so the environmental carrying capacity of development activities should be evaluated from the perspective of urban planners, where the concept indicates the maximum economic scope that can be supported by the environmental base (Moukhtar et al., 2020).

It is necessary to address and mitigate these pressures because their accumulation will affect the environment directly and indirectly in the long run on the ecosystems and their services, which includes harmful effects of the deterioration of the state of living organisms and human health.

Therefore, the action here is more directed towards two paths:

1 application of government strategies to preserve the environment;
2 development of a set of adaptation and censorship plans specific to the study area through applying the ecosystem-enriched (eDPSEEA) framework.

The first path consists of:

- rational and sustainable management of natural resource assets to support the economy and increase competitiveness by finding non-traditional alternatives to ensure their sustainability;
- preserving the balance of ecosystems and biodiversity and their rational and sustainable management (Sustainable Development Strategy Egypt 2030; MPED, 2021).

However, the first track must be applied, as it is taking place at the scale of the whole country, and on the governorates with the same approach and methodology, while not putting into consideration the specificity of the case, the different nature, values, and environmental characteristics of any of them. Therefore, it is necessary to apply the other path, which is compatible with Fayoum governorate's environmental character and characteristics.

The adaption and censorship plans are as follows:

- educate the public on how to care for the environment and ecosystems;
- improve the coordination between planning and design authorities;
- constantly monitor ecology changes;
- increase the percentage of green areas, to minimize the number of pollutants;
- achieve a balance between development and the environment;
- create stringent standards and procedures for pollutant-producing activities;
- strengthen governing laws for development activities that have an impact on ecoregions of a special nature;
- increase the population's quality of life through establishing equality in basic services safely and healthily;
- activate systems for incorporating environmental sustainability criteria into a long-term growth strategy;
- activate the initiative "Greening National Plan" at all development processes;

- rely on the principles of the green economy to guide economic growth;
- use environmental performance indices in all development sectors to ensure sustainability;
- support nature reserves and national conservation programs.

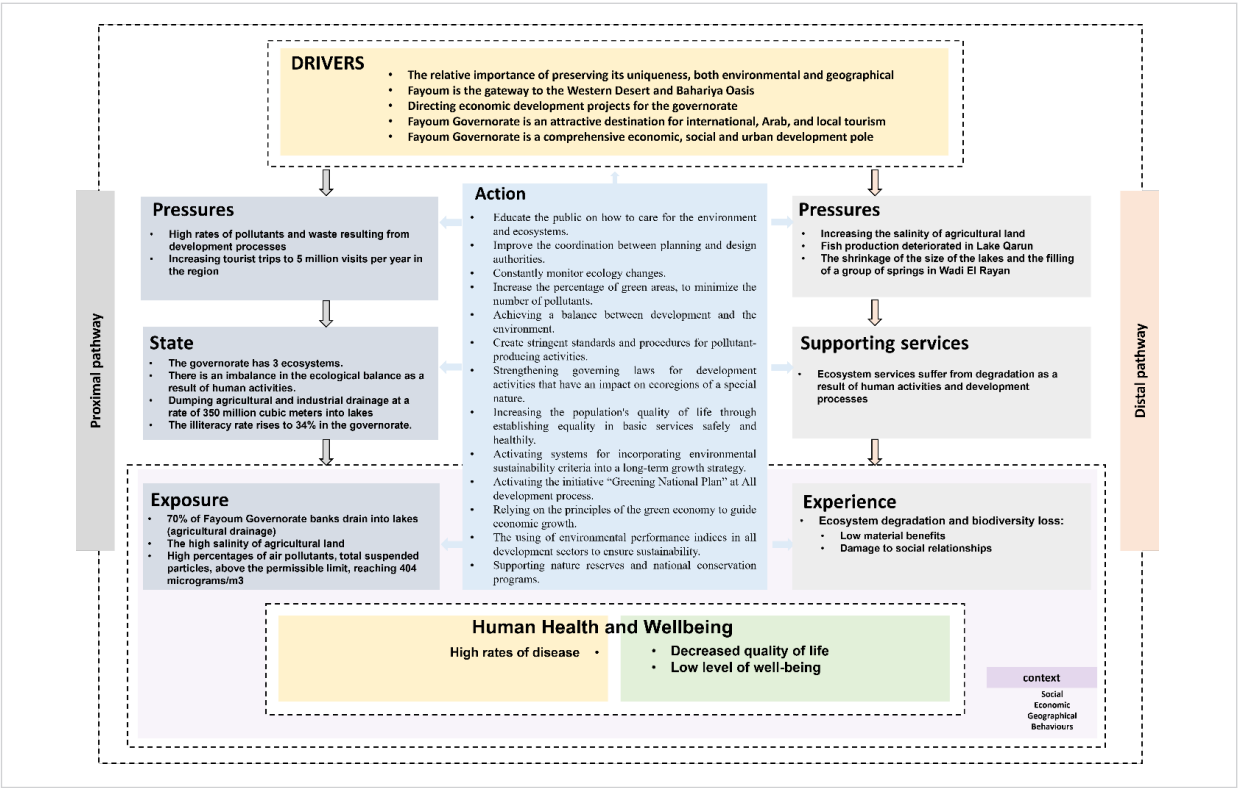
Through applying these plans, it is possible to achieve environmental sustainability and preserve the environment and ecosystems in Fayoum Governorate.

Conclusions and Suggestions

The results of previous analyses confirm that Fayoum Governorate suffers from a deterioration in the natural environment and human health in it because of development processes and human activities. The previous steps of the analysis showed that Fayoum Governorate has high rates of pollutants resulting from human and economic activities (industrial activities, mineral extraction, agricultural activities). Ecosystems suffer from deterioration such as shrinking the size of lakes, low fish production, low agricultural production due to high salinity, farmland. There has been an ecological imbalance in the governorate, and exposure to environmental pollutants has resulted in a decrease in human well-being and an increase in the incidence of diseases, as well as a decrease in the quality of life, as a result of the deterioration of the governorate's infrastructure. It also demonstrates that as social, economic, and urban growth expands, environmental repercussions expand and become more complex. As a result, a set of policies and procedures have been put in place to keep the environment, ecosystems, and human health from deteriorating. They were directed to the application of state strategies to preserve the environment, with the development of a set of plans and strategies that work on adaptation and continuous control of the environment and all activities, such as raising awareness of the importance of preserving the environment and thinking about the implications of the framework, including both short- and long-term consequences, which is the best way to establish effective solutions to improve and sustain environmental systems.

Fig. 15 shows the steps and results of the previous analysis.

Fig. 15. *Applying eDPSEEA to Fayoum Governorate (Source: authors)*

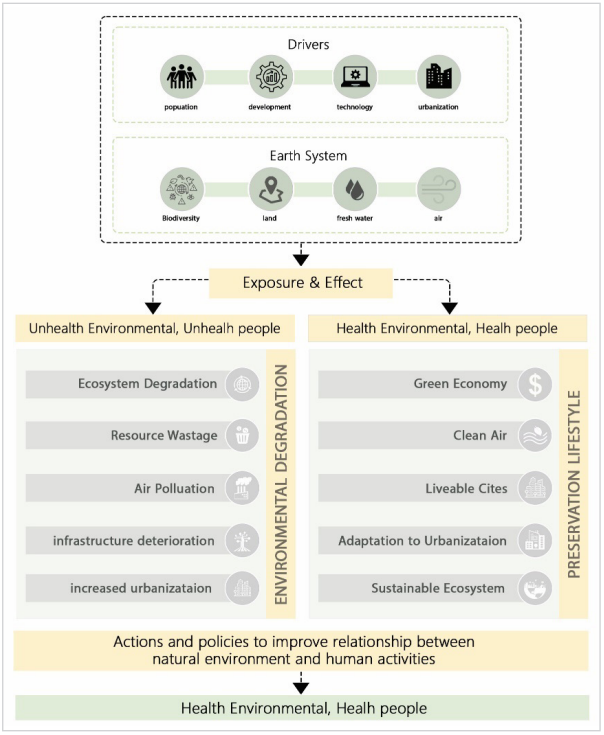


The eDPSEEA framework appears to be suited for the Egyptian case since it demonstrated the link between environmental health and ecosystems in Fayoum Governorate as one of Egypt's governorates, from the identification of the problems' root causes to the development of appropriate measures and answers to their predicament within their setting. As a result, this framework should be used by other governorates that are experiencing degradation to find appropriate remedies and enhance the Egyptian situation's environmental performance to attain the principles of sustainability. As an important tool and a systemic interlocking approach solving problems that include the perspective of understanding the relationship and interactions between many components within the system and the different ecosystems, this framework helps to expand the decision-making and implementation processes by looking at more than one issue within the system in all sectors.

The framework also assists decision-makers and stakeholders in identifying weaknesses and challenges that must be addressed through the development of strategies and procedures to achieve sustainability while confronting and preparing for the risks that they may face, and work to achieve sustainability as shown in *Fig. 16*.

From the results of analyzing those models, we note that all the pillars are concerned with understanding the relationship between human activities, the physical environment, health, access to a healthy environment, and achieving sustainability.

Fig. 16. *The importance and impact of applying the framework on the Egyptian case (Source: authors based on Global Environment Outlook)*



References

Andrews, A. (2014). FRESH. Thinking for a new era in environmental health and well-being.

Anwar, W. A. (2003). Environmental health in Egypt. International journal of hygiene and environmental health, 206(4-5), 339-350. https://doi.org/10.1078/1438-4639-00230

Baghdadi, M., Desouky, M (2017). Sustainable development and environmental sensitivity of the Qarun Lake region. Journal of the Egyptian Scientific Academy,92 (92), 351-358.

Bakumenko, L. P., Sarycheva, T. V., & Korotkov, P. A. (2015). The Approach to Major Cities Environmental Performance Measurement. Mediterranean Journal of Social Sciences, 6(3 S7), 333-333.

Briggs, D. J. (2008). A framework for integrated environmental health impact assessment of systemic risks. Environmental health, 7(1), 1-17.https://doi.org/10.1186/1476-069X-7-61

Briggs, D., Corvalan, C., & Zielhuis, G. (2000). Decision-making in environmental health: from evidence to action. Routledge. https://doi.org/10.4324/9780203479018

Carmichael, L., Racioppi, F., Calvert, T., & Sinnett, D. (2017). Environment and health for European cities in the 21st century: Making a difference.

Center for Information and Decision Support. (2021). Information note for Fayoum Governorate.

Central Agency for Public Mobilization and Egyptian Statistics (2017) General Census of Population and Establishments 2017. Arab Republic of Egypt.

Central Agency for Public Mobilization and Statistics (2020) Annual Bulletin of Environment Statistics Part Two: Environmental Quality and Energy 2018. Arab Republic of Egypt.

Central Agency for Public Mobilization and Statistics (2020) Statistical Guide.

Central Agency for Public Mobilization and Statistics of Egypt (2020) Annual Bulletin of Fisheries Production Statistics 2018. Arab Republic of Egypt.

Development Research and Consultation Center, Fayoum University. (2009). Development prospects in Fayoum Governorate. The Egyptian Arabic Republic.

Dodman, D., McGranahan, G., & Dalal-Clayton, B. (2013). Integrating the environment in urban planning and management: Key principles and approaches for cities in the 21st century. UNEP.

Egyptian Environmental Affairs Agency (2018) News Center https://www.eeaa.gov.eg/ar-eg/%D8%A7%D9%84%D9%85%D8%B1%D9%83%D8%B2%D8%A7%D9%84%D8%A7%D8%B9%D9%84%D8%A7%D9%85%D9%89/%D9%85%D8%B1%D9%83%D8%B2%D8%A7%D9%84%D8%A7%D8%AE%D8%A8%D8%A7%D8%B1.aspx.

Egyptian Environmental Affairs Agency, Environmental Characterization of Fayoum Governorate. Ministry of State for Environmental Affairs Agency.

Ekins, P., Gupta, J., & Boileau, P. (2019). Global Environment Outlook-GEO-6: healthy planet, healthy people.

Environmental Sustainability Standards Guide "Green Recovery Strategic Framework 2021".

Gad Al-Rub, Mohamed, Y. (2008). The economic resources of Fayoum Governorate (case study) using geographic information systems. Faculty of Arts, Department of Geography, Zagazig University.

General Organization of Physical Planning (2014) the strategic plan for Fayoum Governorate, Arab Republic of Egypt.

General Organization of Physical Planning (2014) the strategic plan for the northern Upper Egypt region. The Arab Republic of Egypt: Ministry of Housing and Public Utilities.

General Organization of Physical Planning (2016). Strategic plans for land development around development axes the first phase: a developmental vision for land uses and the proposed roles for each axis in its domain.

General Organization of Physical Planning (2017) Modernization of the strategic plan for Fayoum Governorate. Ministry of Housing, Utilities and Urban Development. Arab Republic of Egypt.

General Organization of Physical Planning (2017) the future vision and projects supporting the development of Fayoum Governorate. Arab Republic of Egypt: Ministry of Housing, Utilities and Urban Communities.

General Organization of Physical Planning (2021) updating the strategic plan for urban development for the northern Upper Egypt region and its governorates and the development features of its centers. The Arab Republic of Egypt.

Hambling, T., Weinstein, P., & Slaney, D. (2011). A review of frameworks for developing environmental health indicators for climate change and health. International journal of environmental research and public health, 8(7), 2854-2875. https://doi.org/10.3390/ijerph8072854

Lam, S., Leffley, A., & Cole, D. C. (2015). Applying an Ecohealth perspective in a state of the environment report: Experiences of a local public health unit in Canada. International journal of environmental research and public health, 12(1), 16-31. https://doi.org/10.3390/ijerph120100016

Le Anh, H., & Schneider, P. (2020). A DPSIR Assessment on Ecosystem Services Challenges in the Mekong Delta, Vietnam: Coping with the Impacts of Sand Mining. Sustainability, 12(22), 9323. https://doi.org/10.3390/su12229323

Ministry of Planning and Economic Development, United Nations Development Program, Egypt Human Development Report 2021 Development is a right for all: Egypt, the journey, and the path.

Ministry of Planning and Economic Development. (2021). Environmental Sustainability Standards Manual (Strategic Framework for Green Recovery).

Morris, G. P. (2010). Ecological public health and climate change policy. Perspectives in Public Health, 130(1), 34-40. https://doi.org/10.1177/1757913909354149

Morris, G. P., Beck, S. A., Hanlon, P., & Robertson, R. (2006). Getting strategic about the environment and health. Public health, 120(10), 889-903. https://doi.org/10.1016/j.puhe.2006.05.022

Morris, G. P., Reis, S., Beck, S. A., Fleming, L. E., Adger, W. N., Benton, T. G., & Depledge, M. H. (2017). Scoping the proximal and distal dimensions of climate change on health and wellbeing. Environmental Health, 16(1), 69-76.https://doi.org/10.1186/s12940-017-0329-y

Morris, G. P., Reis, S., Beck, S., Fleming, L. E., Adger, W. D., Benton, T. G., & Depledge, M. H. (2015). Climate change and health in the UK. Scoping and communicating the longer-term "distal" dimensions. Health Climate Change Impacts Summary Report Card, Living with Environmental Change; Kovats, S., Ed.

Morris, G., Staatsen, B., & van der Vliet, N. (2019). Using conceptual models to shape healthy sustainable cities. In Integrating Human Health into Urban and Transport Planning (pp. 683-706). Springer, Cham. https://doi.org/10.1007/978-3-319-74983-9_33

Moukhtar, I., Ibrahim, A. A., Abou El Seoud, T., & Mostafa, S. (2020). Assessment of the Environmental Carrying Capacity for Protected Areas: A Study of Petrified Forest and Hassanah Dome, the Great Cairo. Environmental Research, Engineering and Management, 76(4), 106-117. https://doi.org/10.5755/j01.erem.76.4.26665

Najati, H. (2017). Studying the extent to which governance is applied to sustainable production and consumption of natural resources in Egypt.

Porche, D. J. (2004). Public and community health nursing practice: A population-based approach. Sage. https://doi.org/10.4135/9781483328669

Reis, S., Morris, G., Fleming, L. E., Beck, S., Taylor, T., White, M., & Austen, M. (2015). Integrating health and environmental impact analysis. public health, 129(10), 1383-1389.https://doi.org/10.1016/j.puhe.2013.07.006

Schirnding, Y. V. (2002). Framework for linkages between health, environment, and development. Health in sustainable development planning: the role of indicators, 105-120.

Sustainable Development Strategy Egypt 2030.

The Ministry of Planning, Follow-up and Administrative Reform (2021) the electronic portal of the Fayoum Governorate, Fayoum Governorate: http://www.fayoum.gov.eg/dalel/default.aspx

Van der Vliet, N., Staatsen, B., Kruize, H., Morris, G., Costongs, C., Bell, R., ... & Schuit, J. (2018). The INHERIT model: A tool to jointly improve health, Environmental sustainability and health equity through behavior and lifestyle change. International journal of environmental research and public health, 15(7), 1435. https://doi.org/10.3390/ijerph15071435

von Schirnding Y. E. (2002). Health-and-environment indicators in the context of sustainable development. Canadian journal of public health = Revue canadienne de sante publique, 93 Suppl 1(Suppl 1), S9-S15. https://doi.org/10.1007/BF03405112