A Comparative Assessment of State of Environment Report in Tehran and Sydney, With an Emphasis on Sustainable Cities' Criteria

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ABSTRACT: One of the most comprehensive tools to show the changing trend in urban ecosystems is by providing periodic State of Environment Report (SoER) for cities in national programs, wherein it is quite essential to have a truthful and realistic view of the current state of the environment as well as significant human impacts. Developing countries like Iran are faced with incoherent and deficient SoER; due to lack of data, which originates from neglecting environmental issues such as poverty, overpopulation, etc. The present study makes a comparative assessment of Tehran and Sydney's SoER in terms of sustainable urban environment indicators with the purpose of recognizing the weaknesses and strengths as well as finding the most important gaps in Tehran's SoER, which can be a useful resource for decision-makers. Results indicate the necessity of establishing integrated urban environmental management. On the whole, this paper recommends programs of environmental development and implementation as suggested strategies to reduce uncertainty and increase the reliability of SoER in the study area.

Keywords: Urban quality, sustainable cities, environmental indicators, environmental management.

INTRODUCTION[*]

Cities are the most dramatic manifestations of human activities on surface of the earth (Yigitcanlar & Kamruzzaman, 2015). Today more than half of the world's population lives in urban areas, and the future of humanity is absolutely urban (Mclaren & Agyeman, 2015). Urban areas are the center of economic development where sustainability is a critical concern (McCormick & Kiss, 2015). The conversion of Earth's land surface to urban uses is one of the irreversible human impacts on global biosphere, which hastens the loss of highly productive farmland, affects energy demand, changes the climate, modifies hydrologic and biogeochemical cycles, fragments the habitats, and reduces biodiversity (Seto et al., 2011). In rapidly-urbanizing areas, agriculture intensifies on remaining undeveloped land and is likely to expand to new areas, putting pressure on land resources (Jiang et al., 2013). A State of the Environment Report (SoER) is a description and explanation of environment's condition that provides

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information for decisions about sustainable management, while measuring the impact of those decisions on the environment (DALA, 2005). A SoER covers the condition of environmental parameters in a predefined geographical area as well as a certain period of time (Wells, 2003). It is difficult to design and apply a single integrating assessment and reporting system that is equally effective for biophysical and human elements of highly complex natural ecosystems, constructed environments, and cultural heritage at a national scale (Ward et al., 2015). In this respect, SoER should be designed at multiple levels (national, urban, and neighborhood-based). So far, the SoER has been prepared at two levels of national and urban development in the world, e.g. Ethiopia (EPA, 2003), Rockingham (EPA, 2007; 2009), Scotland (Critchlow-Watton, 2014), Uganda (NEMA, 2010), Bangladesh (United Nations Environment Program, 2001), Abu Dhabi (Environmental Agency-ABU DHABI, 2017), Delhi (Department of Environment and Forests, 2010), London, and Sydney. What is evident from reviewing these reports is that there is no single format for them; moreover, they have been prepared in accordance with the environmental conditions and factors. Therefore, by conducting a comparative analysis, the current study makes a systematic review of the existing literature on SoERs. Previous successful experience from sustainable cities, such as Sydney, London, etc., wherein reports are provided regularly, have also been taken into consideration. In order to enrich Tehran's SoER, it is essential to understand the procedure and factors, involved in successful cases. Fortunately, Tehran is among pioneer cities in preparing SoER (Zebardast et al., 2015); even though, this report is incoherent and deficient, due to lack of data, which originates from neglecting environmental issues like poverty, overpopulation, and war.

Therefore, it is required to amend the applied methodology of preparing such a report, which may also entail systematic planning to resolve the environmental problems of Tehran. To do so, it will be efficient to utilize updated methods (such as DPSIR model) that detect environmental problems with scientific approaches and resolve them thoroughly and basically. DPSIR is an integrated and holistic cause and effect model as well as a tool to integrate the economic, social, and natural systems into a systemic approach that provides a basis for a more detailed analysis (Bidone & Lacerda, 2004). DPSIR has been widely adopted to analyze the interacting processes of human-environmental systems (Pinto et al., 2013; Hou et al., 2014).

The main goals of this study are providing a comprehensive assessment of Tehran's SoER, identifying environmental trends and impacts, and formulating policy options for decision-makers. To achieve these, SoER of Tehran and Sydney are to be investigated in terms of various factors that consider their differences. The factors in SoER will be compared with sustainable city indicators for the assessment of these cities' status in this regard. The results will recognize both the weaknesses and strengths, determining important gap items in Tehran's SoER. This can be a useful resource for decision-makers to develop strategies for meeting the goals in comprehensive and detailed design plans. Besides, it facilitates sustainable development of the study area along with economic, social, and environmental welfare of its inhabitants. In fact, the study seeks to answer the following important questions:

- What is the current environmental state of Tehran city, its inhibitors, and the threats on the way towards sustainable urban development?

- How can institutional and social capacities be developed and further enhanced for the formation of comprehensive and efficient SoER of Tehran?

MATERIAL AND METHODS

The method, applied in this study, is a comparative analysis of SoER in Tehran and Sydney. Reporting patterns can be compared in terms of reference models, time patterns, and indicators. As such, SoER of Tehran and Sydney was initially evaluated on the basis of four evaluative criteria, namely spatial and temporal scale, actors' organizations, vision/purpose, and component. Subsequently, the status of these two cities was assessed and analyzed in terms of sustainability and according to the indicators of sustainable cities.

Urban sustainability indicators are a tool that enable city planners, managers, and policymakers to gauge the socio-economic and environmental impacts of access to services by citizens. The indicators allow for the diagnosis of problems and pressures, as well as subsequent identification of areas that would profit from being addressed through good governance and science-based responses. In addition, the success and impact of sustainability interventions in cities can be monitored (Science for Environment Policy, 2015). Urban health, sustainable environment, the degree of satisfaction and happiness, educational structure, and desirable state systems have been identified as the five main indicators of assessing sustainable cities (Tabucanon, 2008). Based on SoERs, radically-sustainable environment indicator was taken into consideration along with the main indicators and their sub-indicators (Holden, 2006). Fig.1 illustrates the study's flowchart.

There are three main documents and studies in the field of Iran's environmental state report, viz., Iran's national report on the state of the environment, Tehran's first state of environment report, and Tehran's second state of environment report. These reports are aimed at examining the environmental state of Tehran when reaching the goals of city's long-term development vision and Iran's 20-year vision plan. According to them, Tehran will be a metropolis with national and global performance, modern economy, the center of cultural affairs, science and politics in the Iran, and one of the top three cities in Southwest Asia.

Tehran's First State of Environment Report: Research and Planning Center of Tehran City was deemed responsible for Tehran's comprehensive environmental report preparation during 2007-2008. The report provided an overview of Tehran's socio-economic situation, also identifying and assessing key environmental issues of Tehran (including air, water, land, biodiversity, natural disasters, waste, and human settlements) based on DPSIR Model (Research and Planning Center of Tehran, 2012).

Tehran's Second State of Environment Report: The University of Tehran prepared Tehran's second SoER between 2008 and 2010. This research focused on formulating a framework for research, collection, and updating data, related to the environmental state in Tehran, mapping them for analytic interpretation and conclusion. The city of Tehran was divided into eight parts with different components from the viewpoint of the environment (Table 1). Selected indicators were structured in form of DPSIR Model for each component, with the data for each indicator, collected and analyzed.

Sydney City, Australia

The City of Sydney is recognized as a leading environmental performer, working towards a sustainable future for its use of water, energy, and waste. The most important problems in Sydney include climate change, emissions, green structures, waste, wastewater, transportation and renewable energy, and land management (Green Environmental Sustainability Progress Report, 2015).
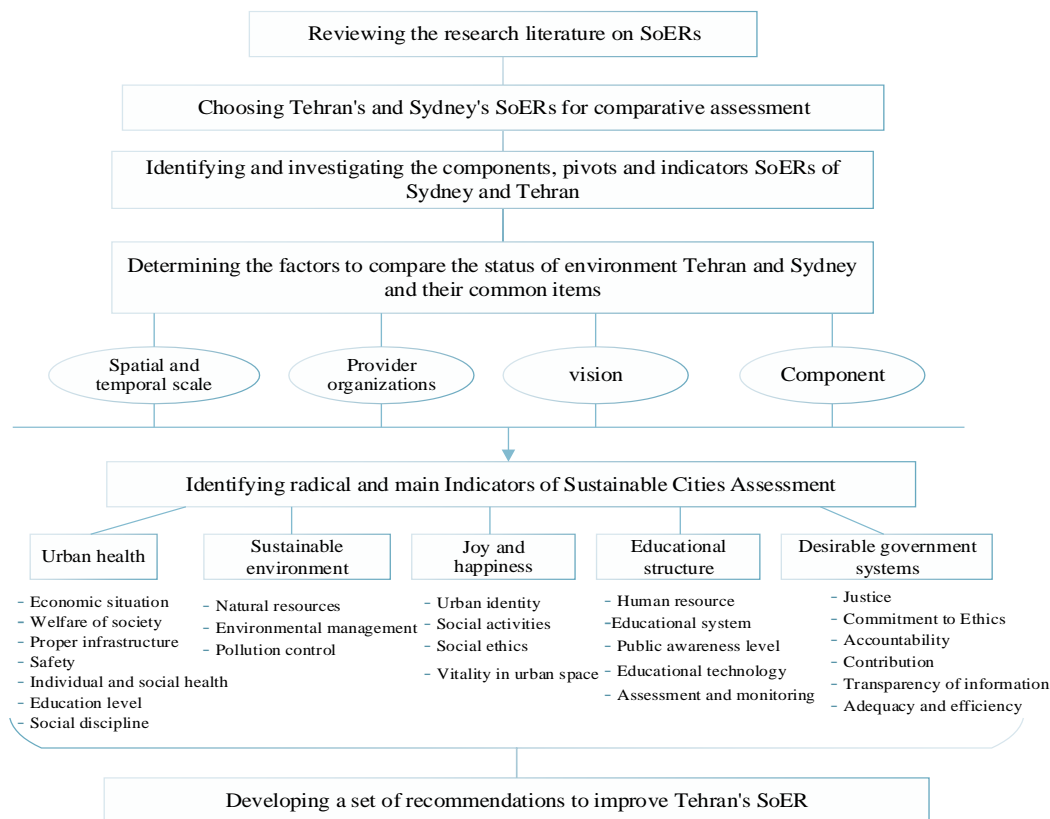
Fig. 1. Flowchart of the study's steps.

Australia's State of Environment Report: Australia is one of the most successful countries in the field of environmental state assessment, having its national environmental reports published every four years. The fourth report was conducted by an independent committee (SoEC, 2011), built on the foundations provided by earlier national SoER assessments as well as state and regional-level environment reports (e.g. GBRMPA, 2009; Dobbs et al., 2011), which were based on the conceptual framework of DPSIR Model. The actors' organization is the Department of Sustainability, Environment, Water, Population, and Communities (DSEWPC, 2011). Based on the latest national report, the Department of Environmental Science conducted a comprehensive review of the state of environment, highlighting the pressures, driving forces, and management plans for all concerns, environmental impacts, and resilience (State of the Marine Environment Report for Australia, 2000; SoER 2011/2012; NRMMC, 2010).

Sydney's State of Environment Report: The city of Sydney's SoER has been produced annually since 2001, its last issue published in 2015. The municipality and environment organization persistently refer to these reports, aiming at sustainable state of Sydney by 2030, viz., having a green and global city, as well as city's environmental managementy (SoER, 2012/2013). The reports, however, present no specific model to analyze the data, only displaying them through graphs (SoER, 2012/2013). In recent reports (2014-2015 years), Sydney explores the environmental conditions, based on its local-level components. It is believed that at this level infrastructure should be managed, so that higher levels can be managed properly (SoER, 2014/2015).

RESULTS AND DISCUSSION

Table 1 compares the SoER of these two cities, illustrating that Sydney has a more precise timeline and spatial scale of reporting, since it examines the state of the current year on a local scale, while only two reports have been prepared in a three-year interval in Tehran.

Table.1. Investigated factors to compare the status of environment in both Tehran and Sydney along with their common items

City	Spatial and temporal scale	Actors organizations	Vision/ Purpose	component	Results and Output	Common component
Sydney	Each year -City (districts and neighborhood)	The Municipality of Sydney and the Ministry of the Environment	Sustainable Sydney 2030 (Changes in the lifestyle, our work and role in the city, now and in the future)	Energy	Sydney should provide hundred percent of the energy needs of indigenous and renewable energy resources within the local boundaries.	*
				Climate change	Climate change is the biggest challenge Sydney faces and identification of alternative energy sources, such as renewable energies, remains a priority in existing state reports.	
				Transportation	New projects such as bus safety improvement, livable green routes network projects, etc., lead to the creation of networks, connecting the sidewalks and bicycle networks.	
				Waste and recycling	Advanced waste treatment and recycling up to 40 thousand household and commercial wastes is one of the main goals.	*
				Water	Increasing water productivity in buildings and green space irrigation systems. Having a local source of recycled water and reuse of recycled water in the neighborhoods are one of the most important outcomes of Sydney SoER.	*
				Green Sydney	Sydney's ecological health, which not only guarantees conservation of biodiversity but improves the quality of citizens, has many economic, environmental, and social interests.	
				Land and noise	As its population grows, Sydney puts its policies in place to increase the authority of the local government to manage land and noise in order to manage both land and social responsibilities.	
Tehran	two, three-year intervals city- regions	Center for Urban Studies and Planning	Tehran's long-term development - Twenty years old vision	Air	Concentration and population density are the most important driving forces behind air pollution due to the need for transportation and, consequently, the use of fossil fuels.	
				Water	Urban population increases, thus increasing number of immigrants, the type of demand, citizens' consumption, and the geographical location of Tehran has worsened water challenges facing the city.	*
				Soil	The industrial activities in the city and the final influx of air and water pollution have also led to the accumulation of hazardous pollutants in the soil, capable of posing very serious health risks for citizens.	
				Biodiversity	Habitats are changing due to unconventional construction, extreme pollution of air and water resources, cutting the conversion and use of old orchards, and climate change.	
				Natural disaster	Tehran is vulnerable to natural disasters due to its natural characteristics. A variety of natural disasters, surrounding the city, are exposing every corner of it to a dangerous event.	
				Energy	The consumption of energy as well as the production and emission of pollutants has had a major impact on the environmental conditions of the city.	*
				Human habitat	Tehran's development during the last half century has not been subjected to any discipline and is an exception among the metropolises of the world in this regard.	
				Waste	Municipal solid waste production is one of the most important challenges that Tehran is faced with.	*

Sydney's SoER was provided by two local and regional policymakers; while, that of Tehran was provided by the Center for Urban Studies and Planning. This shows that Sydney did pay and is paying more attention to preparation of SoER, since its reports were prepared by various organizations, observed and reviewed for the principle of multi-scale environmental issues. Sydney sustainable 2030 vision is the focus of selecting indicators and sub-indicators in Sydney's SoER, being more fundamental and specific than Tehran; therefore, the indicators in Tehran's report were somewhat more general than Sydney. Particular attention was paid to climate change as a natural disaster in Sydney, while in Tehran it was pollution to receive the greatest attention.

According to the results from Table 2, among the indicators of the sustainable environment, reviewed in these reports, pollution enjoyed the lion's share with 47 %, whereas national resources with 33% and environmental management with 20%

were placed in the second and third, in terms of sub-indicators for each main indicator. Biodiversity protection and green space provision had the highest ranks (Fig. 2). The technology, employed to improve public awareness, and sustainable products had the lowest ranks in terms of the number of sub-indicators in both Tehran and Sydney. As a result, the main components considered in SoER were in accordance to the specific conditions in Tehran, themselves consistent with the sustainable environment indicators. The reason for choosing the components, indicators, and sub-indicators of the Sydney was the focus of Sydney sustainable 2030 vision on these issues. According to the analysis of Sydney's SoER during 2006-2015, significant points of focus included locating indices at local scale and public participation (SoER, 2006/2007; SoER, 2013/2014), not to mention waste and wastewater recycling (Waste and recycling, 2015).
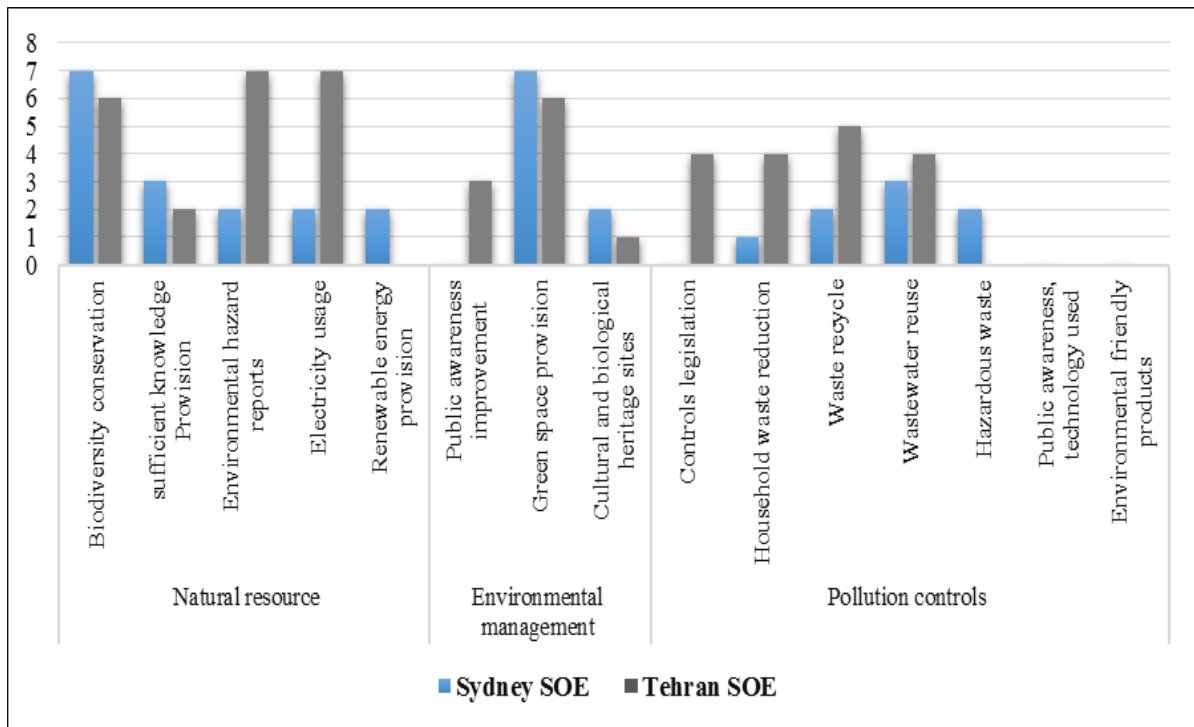

Fig. 2. Comparison of Sustainable City sub-indicators in the SoER of Sydney and Tehran

Table. 2. Sustainable Environment Indicators and sub-Indicators in SoER of Tehran and Sydney

Radical indicator	Main indicator	Sub indicators	Sydney	Tehran
Sustainable environment	Natural resource	Biodiversity conservation	The number of: Protection groups for urban bustards Registered bushings, registered volunteers Native species planted by volunteers. - Vulnerable plant and animal species - Endangered plant and animal species	Number and population of vulnerable species; structural disturbances of landscape; changes of natural habitats to other uses in sensitive ecological areas; biodiversity laws and regulations
		sufficient knowledge	Holding participatory programs; holding joint meetings among different groups to exchange knowledge; holding weekly meetings to increase local knowledge	Creating a database for environmental indicators; Holding a workshop on the environmental state of Tehran
		Environmental hazard	Decrement measures in the context of climate change; reducing fire hazards in forest areas	Population vulnerability to hazards; buildings and worn out textures; resistance and resilience to dangers
		Use of Electricity	Sydney's consumption in terms of domestic and commercial sectors and large commercial enterprises from 2005 to 2012; the use of municipality and government departments	The portion and hydroelectric capacity in the total; Tehran electricity production; the portion and capacity of gas power plants to generate electricity; the portion and capacity of diesel power plants in electricity production
		Renewable energy	Solar energy, entering the network, the amount of solar energy, entering the network from the city council	NS=Not studied
	Environmental management	Public awareness	NS	Encouraging citizens to plant vegetation on the roofs; training to take preventative measures in relation to natural disasters; per capita plans for water conservation on local broadcasting
		Green space	The number and area of green roofs and walls; number of public gardens, irrigation of gardens through people, new and replaced trees on the streets of Sydney	Total space of green space per capita in Tehran; the city's public parks and gardens; reduced natural and open spaces; construction of Tehran's green belt
		Cultural, biological and heritage sites	Making lists of cultural and biological heritage sites; mapping and valuing cultural and biological heritage sites	Cultural-entertainment places of Tehran districts
		legal controls	NS	Review of laws and standards, activities and studies on air pollution; regulations, guidelines and measures adopted on water pollution; regulations, guidelines for soil contamination
	Pollution controls	Household waste reduction	The volume of waste, produced per person and household	The per capita waste generated by households in Tehran; actions leading to various types of waste production; waste production change trends
		Waste recycling	The volume of recycled waste per person and household; Waste recycling from city councils	Waste management facilities state; utility and recycling stations; complexes for processing waste disposal; approvals and management measures for waste collection and disposal
		Wastewater reuse	Recovery rate at power plants; conversion rates of wastewater to biofilms and thermal energy generation; recycling waste	Wastewater treatment usage for plants, irrigating agricultural products; comprehensive study of sewage system; the share of recycled water from water resources
		Hazardous waste	The number and area of hazardous waste landfills; required facilities for dumping and disposal of hazardous waste	NS
		Public awareness	NS	NS
		Environmental products	NS	NS

Detailed strategies and programs for each respective indicator makes up Sydney reports' strength. To illustrate this with an example, it can be noted that Conservation Strategy Program (NRMMC, 2010), Greening Sydney Plan (Greening Sydney Plan, 2012), and a comprehensive strategic toilet program, are all featuring detailed surveys at Sydney metropolitan area, capable of being considered a very strong database for future and ongoing reports. Sydney's reports address the challenges of climate change (Urban Ecology Strategic Action Plan, 2014), while in Tehran there

is no special plan for creating such a database to support SoER. The reviews of the sub-indicators are presented below:

Biodiversity conservation: Tehran has high biodiversity potentials, due to its geographical and climatic conditions; however, species' habitats are changing and degrading in the city, due to extraordinary constructions, high air and water pollution, conversion and land use changes in case of old orchards, climate change, and lack of attention to the value of biodiversity. All these factors are well addressed in Tehran SoER and it is projected to prevent more pressure and unsustainable use of nature. The whole country of Australia, including the city of Sydney, has a Biodiversity Conservation Strategy 2010-2030 report and Green Programs, included in Sydney SoER to develop biodiversity indicators. The focus of Sydney SoER on the Biodiversity Conservation Index is local and determined through public participatory meetings.

Sufficient knowledge provision: The focus of Tehran SoER is to develop a framework for research, compilation, and updating of data, so that they can become relevant, not to mention to interpret and conclude the data. The database is designed to provide a format that can be linked to GIS-related files, providing sufficient knowledge for updating the data. In Sydney SoER, however, in order to expand this index, more emphasis is put on increasing interaction and giving information to local people so that environmentalists can exchange knowledge through community-level meetings, in effect a kind of social learning.

Environmental hazards: Tehran is a large city, highly potential of catastrophic events. The multitude of natural disasters, surrounding the city, are exposing every corner of it to a dangerous event; therefore, natural disasters like earthquake, flood, landslides, frost, heat wave, desertification, drought, and land degradation have been

considered in Tehran SoER. The Sydney SoER also addresses the impacts of climate change, providing detailed resilience reports of the city to combat climate change as well as fire risks.

Use of electricity: Three parts of supply, conversion, and energy demand along with generation and emission of pollutants from them have been analyzed within energy category in Tehran SoER. In addition to electricity, other types of energy have also been investigated according to various indicators such as economic, social, and pollution indicators from production and energy consumption. Sydney has policies for the use of renewable energies and reducing power consumption. It can be said that Sydney has developed local-level indicators.

Alternative energy provision: This indicator is not included in Tehran SoER. On the contrary, Sydney SoER has pointed water and electricity resources provision from renewable local resources, such as reusing urban runoffs to provide water energy and using local solar cells to meet thermal requirements of the same site.

Public awareness improvements: Considering the cultural conditions of Tehran citizens, cultural measures are required for all solutions, e.g. encouraging citizens to separate different types of solid waste. The strategy of cultural measures and increased public participation has been proposed in Tehran SoER, even though this indicator is not included in Sydney SoER.

Green space provision: The components of human habitat, air, soil and biodiversity, green space per capita, rate of conversion, reduction of natural areas, and open spaces have been addressed in Tehran SoER. According to Sydney Green Report, Sydney SoER has been studied in detail in this regard, as shown in Table 2.

Cultural and biological heritage sites: In terms of human habitat, the state of cultural-entertainment places has been considered very briefly with natural

heritage sites not considered in Tehran. As for biodiversity, protected areas and natural habitats have been studied in Tehran SoER. The preparation and listing of cultural and biological heritage as well as mapping and legacy valuation of these areas are considered as indicators in the Sydney SoER.

Establishing legal controls: Legal controls such as laws, regulations, instructions, and all control measures, related to various types of air, water, soil, and energy pollution are detailed in various components in the Tehran SoER. In contrast, Sydney is at a very high level due to environmental standards and control measures; therefore, there is no separate section under this issue, since the city has gone through legislation and control laws for many years and more advanced issues have been included in Sydney SoER.

Household waste reduction: Under the light of waste component, all waste types (i.e., urban, hospital, and construction wastes), waste per capita, their changing trends, and activities leading to the production of various types of waste reduction have been studied and management measures have been provided in Tehran SoER. The rate of household waste generation per household and per person has been addressed in Sydney SoER.

Waste recycling: Urban waste and recycling stations, waste collection, waste landfill, and waste management have been briefly addressed in the waste category of Tehran SoER. Indicators such as the volume of recycled waste from households and waste recycling from the councils at the local scale have been analyzed in the Sydney SoER.

Wastewater reuse: In the water category, the issue of wastewater reuse for irrigation water is briefly discussed in Tehran SoER. The amount of wastewater reuse at power plants, the conversion rates of wastewater into biofuels and the

generation of heat energy, wastewater from domestic, commercial, and industrial sectors (cubic meters) have been considered as indicators in Sydney SoER. Considering Sydney sustainable 2030 vision, reuse measures in the wastewater sector are of great interest thanks to results such as reducing water consumption, reducing water pollution, and tackling the effects of climate change.

Hazardous waste: This component has not been reviewed in the Tehran SoER, though the number and area of landfills of hazardous waste and the number of facilities required for the burial and disposal of hazardous waste have been considered in the Sydney SoER.

General awareness/technology used for environmental friendly products

These components have not been analyzed in neither Tehran nor Sydney SoERs.

CONCLUSION

SoER is usually presented with goals such as defining and spatially representing the constraints and opportunities of city environment. In fact, it complements the regional development frameworks, identifying and reporting developmental trends that might either improve or deteriorate environmental changes. It also gives some recommendations (response to status quo) to improve environmental quality. Cities cannot be properly imagined without identification of environmental status of metropolises from the urban unsustainability point of view. Such a perspective indicates any decrease in ecological capacities, population growth, and ultimately increase in the unsustainability within a wider range of administrative boundaries and even at the regional level. Therefore, SoER is considered much more than mere representation of selected environmental parameters in a specific time. According to the assessment of Tehran and Sydney's

reports on the basis of sustainable city's indicators, both reports include these indicators, while Sydney considers indicators of a sustainable city at different scales more accurately and consistently. In developed countries, such as Australia, the study of the state of environment at a national and international level has been carried out regularly and is repeated at specific time periods. Besides, the database will regularly be updated. Tehran's SoER has been prepared only twice and for three-year periods by various trustees, with a large number of accountable and dispersed institutions, which can exacerbate the impact of major and complex environmental problems. In addition, the majority of time and energy, put in the study of Tehran SoER, has been used to collect necessary data for indexing, which can have effective results on future reports if the study group integrates and facilitates access to required data. It is obvious that the best pattern to analyze the environmental state is to have annual reports. Considering operational impasses for cities like Tehran, it will be effective to provide the reports in a three to five year pattern, accomplishing the ten-year summaries, and establishing a regular basis for reporting and tracking trends and the responses. Having a healthy environment requires a systematic, integrated, and coordinated approach among all involved organizations (including the Department of Environment of Iran, the Tehran Municipality, the Governorate, Iranian Ministry of Energy, etc.) in Tehran. Sydney has used some of the important components appropriate to its specific circumstances, whereas Tehran has also benefited from the conceptual framework of DPSIR. Considering the urban area of Tehran, integrated essence of environment, and the components of the DPSIR model such as propulsion machinery, they are not subject to administrative and organizational patterns. Therefore, it is not rational to accept the division in the municipality of Tehran and its surrounding, as well as various parts of the organizations, and the administrative boundaries and zones.

The components of energy, waste, and water recycling are the common components of both reports. Other components in both cities have been selected based on the environmental necessities and conditions of either city. Tehran has focused on pollution indicators, while Sydney has the issue of climate change. It should be noted that Sydney 2030 vision is based on Sydney City's environmental management goals, actions, and selection of components and indicators, based on its report. The existence of a strong database and annual reports in urban environments greatly help improving the selection of components in Sydney, whereas in Tehran, due to lack of a clearer and more precise perspective, the components are more general and only take critical environmental conditions into consideration. The findings of the environmental report can provide a more comprehensive, multidimensional, and multi-faceted view at a large scale in Tehran metropolis; this report will form the baseline from which to develop better environmental monitoring and sustainable practices for future. Hence, the strategies are proposed to reduce uncertainties and increase the credibility of the results from Tehran's SoER, such as establishment of integrated urban environmental management, formulation and implementation of environmental plans, development of environmental standards, and the necessity to comply with existing standards.

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