Towards Structured Integrated Environmental Approach to Maintain Sustainability in Jordan

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Abstract

As Jordan enters the twenty–first century, it faces enormous environmental problems reflected in pollution and the depletion of natural resources exacerbated by broader economic and political difficulties. In addition, rapid industrialization combined with poor management and monitoring, the absence of appropriate regulation, bureaucracy, and a lack of financial and technical resources and base line information, have traditionally constrained opportunities for effective policy making and action. Nowadays the government, working alongside research institutions and a range of local and international agencies have gained a consensus – to give considerable attention to the development of an integrated strategic environmental approach to include policy-making, environmental planning and program assessments, and the implementation of state – of – the art technologies in the areas of wastewater, solid waste and air pollution management and regulation. This paper presents the historical context, an analysis of the current situation and an assessment of the potential for introducing environmental policy and management programs benchmarked against best-practice in developed countries.

Keywords

Sustainability; Environmental Pollution; Existing Practices; Management; Moving Forwards; Constraints; and Recommendations.

INTRODUCTION

Jordan is considered to be a relatively small country in the Middle East occupying 90,000 km2. It is divided into three main geographical and climatic areas; the Jordan Valley, the Mountain Plateau and the Badia Region (the eastern desert). The total rainfall in Jordan is approximately 8.5 billion cubic meters with about 85% loss by evaporation. In addition, it has about 75% desert climate with annual rainfall less than 200mm. So it is an arid to semi arid country. Moreover, nearly 75% of the population is located in urban areas concentrated in the north and mid-west; in Amman, Irbid, Zarqa and Balgh. The population of Jordan is now 5.2 million with average population growth of approximately 3.5% (AESR, 1998).

During the last decade population growth, rapid industrialization, the raising in standards of living and other related factors have resulted in increased use of natural resources, thus increasing the rate of waste generation and environmental pollution. Jordan is considered to have numerous environmental problems and it is mainly due to the improper management of the natural environment. The country has problems with air pollution, wastewater and solid waste, affecting both human health and the wider environment. The government of Jordan tries to solve these problems through consulting with national and international organizations for the establishment of integrated environmental programs, policies and regulations while striking a

balance with economic development. The government appears to be serious in its attempts to reduce pollution levels and to protect the environment, but legal, technical, social, economical and financial considerations are slowing the progress of solving environmental problems.

While many commentators look to the failure of government regulation, the lack of commitment by government agencies and private companies, and a lack of awareness by the general public, efforts are currently being made to strengthen the existing regulatory structure, implement new projects, initiate Environmental Impact Assessments (EIAs) and build partnership with local nongovernmental and international agencies. The intention is to provide a framework for resolving pollution problems. This paper reviews the main current environmental issues within a framework provided by lessons learned from the country's own experience in addition to other countries successes.

WATER POLLUTION

Water resources in Jordan are limited, with the per capita share among the lowest in the world (presently about 180m^3/capita/year). Resources are already being negatively impacted and are below the water poverty line of 1000m^3/capita/year. Experts predict that the per capita share will be approximately 90m3/capita/year by the year 2025 (MWI, 2004). Water resources consist mainly of surface and ground water, while treated wastewater is being utilized increasingly for irrigation in the Jordan Valley.

Water quality in Jordan is poor due to the contamination by fertilizers and pesticides, discharging municipal and industrial wastewater to rivers, solid waste deposit along riverbanks, and the uncontrolled leaching of Landfills. Due to the shortage in water resources in Jordan, the Ministry of Water and Irrigation (MWI) established a strategy in order to utilize wastewater effluent for irrigated agriculture. To do so, the quality of wastewater should meet the Jordanian Standard based upon the World Health Organization (WHO) guidelines for irrigation water quality. In the year 2000 about 72 MCM/year (MCM: Million Cubic Meters) were generated from wastewater treatment plants. By the year 2020 when the population is expected to be 9.9 million, about 240 MCM/year of wastewater are expected to be generated. (Batanieh F. et al., 2002).

Development and Status of Wastewater Sector in Jordan

Wastewater collection in Jordan began in 1930 - in the town of Al- Salt - a physical process mostly utilising septic tanks and cesspits. Modern technology of collecting wastewater began in 1968 with the Ain-Ghazal Treatment Plant (AGTP) using a conventional activated sludge process. Ain-Ghazal Treatment Plant was designed to handle an average flow of 60,000 m3/d with a BOD5 of 18,000 kg/d. The standard effluent BOD5 of the incoming flow of 600 mg/l at AGTP reduced the effectiveness of the activated sludge process (MWI, 2004). As a result AGTP was closed and As-Samra waste stabilization pond (WSP) began to operate in 1985. The connection of Zarqa and Russeifa instead of building the proposed west Zarqa plant led As-Samra plant to be overloaded. This situation does not meet the Jordanian standard for water quality effluent. Many studies, including those by the Royal Scientific Society (RSS) and the Ministry of Water and Irrigations, revealed ground and surface water pollution within the Zarqa basin resulting from the As-Samra wastewater treatment plant. As its output is one of the main irrigation sources in the Jordan valley, the risk of contamination has consequentially increased.

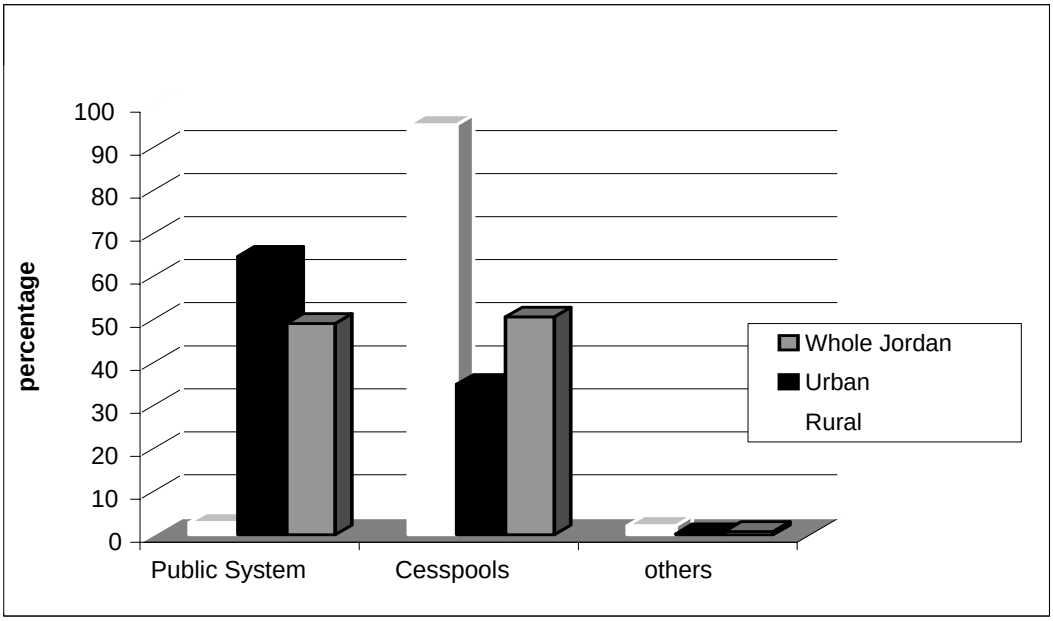
Co-mixing industrial discharges with municipal effluents at the treatment station reduces the water quality and has increased the potential risk to human health and the natural environment.

In 2003, As –Samra wastewater treatment plant 'Build, Operate and Transfer' (BOT) project was started. It is expected that the capacity of the As-Samra plant will be raised from 68,000 m^3/day to 267,000 m^3/day. The construction is expected to be completed by the end of 2006 (BOT, 2000). Many advantages will occur by this project. Firstly, water effluent quality will be suitable for agricultural irrigation. Secondly, it will contribute to achieving self-sufficient energy production. Thirdly, odour will be reduced for local residents. In general terms, the quality of ground water will be enhanced due to improving the quality of treated wastewater.

Level of Wastewater Services

Approximately 65% of the urban population (about 50% of the total population) has access to wastewater collection and treatment systems (Bataineh F. et al., 2002). This improves public health, raises the sanitation level and controls the pollution of surface and ground water. Figure (1) shows the level of wastewater services in urban and rural areas, and in Jordan as a whole.

Figure1 Methods of Wastewater Disposal



Source: (WAJ, 2004).

Existing Treatment Plants and Wastewater Production

There are nineteen wastewater treatment plants. Thirteen are conventional mechanical plants and six employ waste stabilization ponds (WSP). These wastewater plants serve about 2.5 million people (nearly 50% of the population). Different treatment methods are employed in Jordan depending on the location, capacity and reuse requirement amongst other factors. Table (1) shows the types of treatments, design and operating load. Some plants have a biological load that exceeds their design load which affects the performance of these plants.

Table 1 Treatment plants, type of treatment and their design and operating loads

No.	Plant	Type of treatment	Design Capacity m^3/d	Organic Load Kg BOD_5/day	Operating Capacity m^3/day
1	As-Samra WSP	WSP	68000	35768	186081
2	Irbid	B.F + A.S	11000	8800	5735
3	Aqaba	WSP	9000	3510	9310
4	Salt	A.S + P.P	7700	8393	3598
5	Jerash	A.S + P.P	3500	4043	2743
6	Mafraq	WSP	1800	1485	1890
7	Baqa'a	B.F + P.P	12000	3600	11516
8	Karak	B.F + P.P	785	848	1275
9	Abu-Nuseir	A.S	4000	4400	1800
10	Tafila	B.F + P.P	1600	1680	736
11	Ramtha	WSP	1920	1574	1888
12	Ma'an	WSP	1600	1552	1556
13	Madaba	WSP	2000	1700	4611
14	Kufranja	B.F + P.P	1900	1615	1863
15	Wadi Al-Sir	Aerated Ponds	4000	3120	1401
16	Fuheis	A.S	2400	2388	1217
17	Wadi Musa	A.S	3400	3060	532
18	Wadi Hassan	A.S	21000	18900	5735
19	Wadi Arab	AS	1600	1440	280

WSP: Waste Stabilization Ponds
A.S: Activated Sludge
B.F: Biological Filter
P.P: Polishing pond
Source**:** (WAJ, 2000).

SOLID WASTE

Solid waste and solid waste landfills could cause major environmental impacts if not managed properly. Sanitary landfill has evolved over the past 15 years as the ideal method for the disposal of solid waste in Jordan. In the past open dumping and burning of waste was practiced. Many of the final disposal sites still practice improper methods for the disposal of solid wastes and lack the engineering design, processing and operational skills and facilities to offer alternatives. These practices may vary from one site to another in respect to standards and environmental soundness.

Municipal solid waste management has been complicated by the large increases in the volume of generated waste as a result of changes in living standards, in terms of both economic and social conditions. Financial constraints, shortage of adequate and proper equipment and the limited availability of trained and skilled manpower have contributed greatly to the poor solid waste handling and management.

Municipal Solid Waste Generation Rates

The average generation rate of solid waste in the country ranges from 0.34 kg /cap/d to 1.07 kg/cap/d with an average rate of 0.91 kg/cap/d. The per capita production rate in Jordan is similar to the ones of other economically developing countries but less than those of developed countries

(Manoj et al., 2001; MMRD et al., 2000). As for solid waste composition, it is similar to most countries in the region with food waste contributing the largest percentage, 56% as shown in figure 2.2.

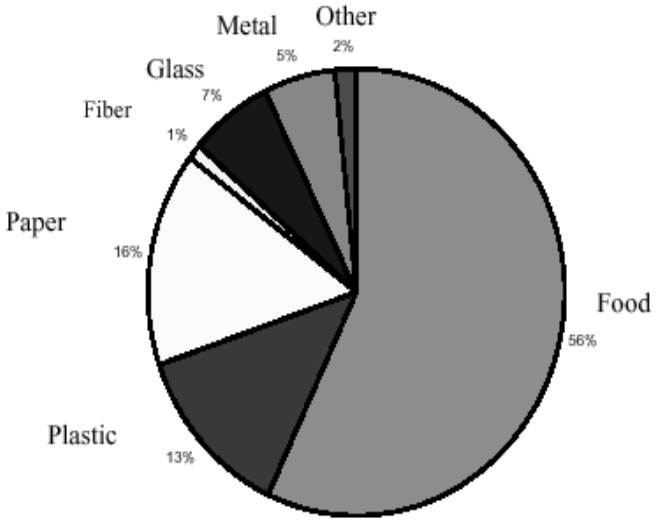


Figure 2-2. MSW Composition in Jordan (% by weight)

Source: MGA (Municipality of Greater Amman), 2000.

Most landfills in Jordan receive industrial, commercial, agricultural and some medical waste in addition to municipal waste. No waste separation or major recycling activities are in place currently. However, increasing attention is being given to waste recovery, recycling and reuse projects and several pilot projects are in place with more at the panning stage. For example, a biogas project was initiated within the last few years with approximately 5.3 million dollars funded by the United Nation Development Program UNDP, Global Environmental Facility (GEF), the Danish government and the government of Jordan. The project is expected to utilize methane for producing electricity with potential of providing 5% of Jordan's electricity, with waste materials utilized for fertilizers (MGA, 2000).

With regard hazardous waste, the country has moved from illegal dumping to the establishment of the Swaga Storage and Treatment Facility (TSDF) south of Jordan. The site has already begun operation and phase two of the project is under preparation (GCEP, 1995-2000).

Landfill Management in Jordan

As indicated by Manoj and his team (Manoj et al.,2001), there are 24 sites for municipal solid waste disposal in Jordan; seven in the northern region, seven in the middle and ten in the southern region as shown in table 2.

Table 2 Location and Capacity of Final Disposal Sites in Jordan

Region	FDS	Location	Area Donum	Quantity (t/day)	Wastes Received
North	1 Akaider	Ramthe	806	350	MSW, Septage industrial medical
North	2 Mafrqaq	Mafraq	180	100	MSW & industrial
North	3 Kufrinja	Ajloon	71	90	MSW
North	4 N Shuneh	N Shuneh	78	100	MSW & medical
North	5 Taybeh	Irbid	60	30	MSW
North	6 Saro	Bani Kinana	55	80	MSW
North	7 Um Qutain	Mafraq	400	30	MSW
Middle	1 Rysseifa	Russeifa	1200	2200	MSW, industrial & medical
Middle	2 Madaba	Madaba	80	150	MSW, medical, industrial & Queen Alia Airport Wastes
Middle	3 Humra	Sult	275	140	MSW & medical
Middle	4 Dhuleil	Dhuleil	70	70	MSW
Middle	5 Thiban	Middle Ghor	30	20	MSW
Middle	6 Dier Allah	Azraq	200	30	MSW
Middle	7 Azraq	Aqaba	48	10	MSW
South	1 Aqaba	Ma'an	60	80	MSW, medical & industrial
South	2 Ma'an	Karak (Lajoun)	502	50	Septage & spent oils
South	3 Karak	Tafila	600	85	MSW & Septage
South	4 Tafila	Shobak	450	50	Medical & Septage
South	5 Shobak	Ma'an	26	20	MSW
South	6 Eil	Aqaba	280	20	MSW
South	7 Quaireh	Huseinyeh	270	20	MSW
South	8 Huseinyeh	S Shuneh	100	15	MSW
South	9 S Shuneh	S Ghor	10	40	MSW
South	10 Shor Safi	Middle Ghor	153	20	MSW

Source: Manoj et al., 2001

Municipality councils called 'common services councils' (CSC) are responsible for managing these landfills. The total solid waste received at these landfills is approximately 3700 tones per day with 680 tones per day generated in northern sector, 2620 tones per day in the middle and 400 tones per day in the southern sectors. The largest landfill in Jordan, located in the middle sector of Jordan is Al-Russifa which receives more than half of the waste generated in Jordan, 2200 tones / day. The second largest landfill, Al-Akaider, located in the northern part of the country, receives about 350 tones per day of municipal solid waste mixed with other wastes including liquid wastes. Several disposal sites receive other types of wastes such as liquid, septic, and medical in addition to industrial and commercial waste. Site selection for the final disposal sites (FDS) were conducted in the absence of feasibility studies that take environmental issues into consideration. Al-Russifa landfill for example was chosen over an abandoned phosphate mine over groundwater aquifer. Whereas Al-Akaider, located on the Jordan/Syria border, caused political tensions and almost to a political crisis when a large amount of stored septic waste flooded into Syria, impacting several farms and endangering the Yarmouk River. Moreover, Al-Akaider dump site is not receiving enough attention; therefore more studies must be conducted to assure that leaching is not contaminating the area's groundwater.

Landfill Practices in Jordan

Landfill methods presently practiced in the country do not meet the international disposal standards in most cases. Gas collection systems are not utilized in any of the FDS except for Al-Russifa where a pilot biogas recovery and conversion project was recently built. Lechate collection system are not used in Jordan, and most if not all landfill liners are compacted solid; while high –density polyethylene or other geo – synthetic fibre are absent. Recently, the government acknowledged the impact of improper land filling on human health and the environment. In response the establishment of Al-Gabawi landfill was a great achievement since the landfill was designed, built and is operating according to international standards in respect to location, topography, and geology, in addition to ground and surface water characteristics, soil conditions, wind directions, rainfall, land use, public health and site infrastructure. All these elements were studied and addressed properly to assure desirable operations. This landfill will be the start and many of the same should follow.

The Jordanian FDSs raise many concerns including: (1) improper design and selection, (2) the receiving of mixed untreated industrial and medical wastes, (3) uncontrolled open burning, (4) widespread open dumping, (5) the shortage of adequate staff and equipment essential for effective operational control, (6) lack of sorting and recycling stations at the sites, (7) the absence of quality control checks, (8) poor management, including training, reporting and lack of awareness and commitment to best practice, (9)shortages of funds, (10) poor handling and processing of refuse from generation to the ultimate disposal .

AIR POLLUTION

Air pollution may be defined as “any atmospheric condition in which substances are present at concentrations high enough above their normal ambient levels to produce a measurable effect on man, animals, vegetation and materials. By ‘substances’ we mean any natural man-made chemical elements or compounds capable of being airborne. These substances may exist in the atmosphere as gases, liquid drops or solid particles.” (Sainted, 1985)

The air quality in Jordan is affected by the emissions of many anthropogenic sources. This includes petroleum refineries, thermal power stations, wastewater treatment plants, solid waste landfills, metal production (primarily steel and iron manufacturing), mining activates, refuse incinerations, coal and oil combustion. These are in addition to natural sources which include wind borne, soil, wild forest fires and bioorganic. For example in the Al-Hashimeya area the main pollutants, which sometimes exceed the limitation of Jordanian standard for ambient air emission JS 1140/1996, are sulphur dioxide emitted from the Refinery and Hussein thermal power station and hydrogen sulphide emitted from As-Samra wastewater treatment plant. Moreover, Al-Russifa landfill generates an abundant amount of methane (CH4) and carbon dioxide (CO2) in addition to other trace elements (METAP, 1997).

Mobile sources, especially traffic pollution, are considered large problem. Unfortunately little attention has been given to this subject. Leaded gasoline and diesel are widely used in most Jordanian vehicles.

POLICY & REGULATIONS

Jordan has many rules and regulations in regard to wastewater discharge, air pollution and solid waste, unfortunately, they are not fully enforced.

Moving Towards Integrated Environmental Management

Having presented a brief analysis of water resources, wastewater and solid waste pollution both in terms of current practice, and also sources, quantities, qualities and overall managements and regulations; the question arises, how can we learn form these? How can we move toward establishing an integrated approach that assures sustainable development?

Starting with the integrated management of water resources one can say that it is of paramount important to the country as a prerequisite for the development of most, if not all, socio-economic sectors. In the absence of reliable assessment of potential issues, suitable and reliable planning for sustainable development is a difficult task.

Water scarcity severely affects the future for irrigated agriculture. With the current situation the country's non-renewable groundwater reserves will be exhausted in 50 years. This will force the country to depend exclusively on renewable water resources. This should be a cause for alarm and create pressure for the urgent creation of effective control polices.

The options for minimizing or managing the worst scenarios for future supplies include:

- Integration of measures for the protection and conservation of water resources.
- Optimisation of water resource allocation and the implementation of appropriate policies.
- Development of a reliable interactive database.
- Active promotion of research and development.
- Development of new alternatives such as :
    - The use of non conventional (reclaimed water) for industrial and agricultural sectors.
    - Improve the effectiveness of irrigation and plant/crop selection.
    - Utilize surface water more efficiently and promote water harvesting.
    - Initiate recycling and reuse in all sectors.
    - Improve community knowledge regarding conservation and usage.
    - Initiate effective water pollution prevention and control programs.
    - Up-grade institutional capabilities for regulating and enforcing water treatment discharge, reuse and land use applications.
    - Raise the efficiency of the water supply network and reduce lost water.
    - Improve wastewater treatment process and introduce new efficient technologies.

While demand management may be less expensive, more sustainable and easier to implement, the limitation of agricultural land has been aggravated by the loss of land for urbanization and industrialization. Therefore, increased control of the transformation of cultivated land into non-agricultural use is very favourable option. This should be supported by the development of indicators for measuring the sustainability of agricultural land use, including monitoring of overgrazing, desertification, deforestation and water harvesting should be primary considerations. To achieve success there must be a reduction in the multiplicity and overlapping responsibilities of institutions related to water and wastewater demand and management, land use and natural resources. Achieving desirable results require comprehensive and integrated

environmental and economic policies. Establishing and up-grading the institutional and financial structure including proper fund allocations and distribution are essential. Moreover, promoting and examining the preferential use of energy sources and the establishments of renewable ones are important elements for achieving successful programs.

The traditional focus on solid waste collection without sufficient focus on how it is to be managed has resulted in health and environmental impacts. The same question arises; how can we minimize health and environmental risks and generate revenue while continuing development? As with water and wastewater management, those seeking to effectively manage solid waste disposal must address planning infrastructure and clean technology applications. The need for effective planning to precede infrastructure investment and for implementation to be considered within a policy framework that includes the involvement of both the private sector and considers public opinion is essential. Moreover, separate and parallel focus on hazardous waste management infrastructure and emissions control must be addressed. Plans for solid waste improvements include:

- The establishment and upgrading of infrastructure including proper collections, storage and transfer. Processing and disposal at modern facilities is desirable on regional basis so as to minimize cost.
- Similarly for hazardous waste treatment, storage and disposal facilities (TSDF).
- Develop recycling activities to include all sectors.
- Up-grade and extend the biogas project and promote marketing and incentives for usage.
- Initiate projects associated with waste utilisations in agricultural applications and encourage the use of compost.

While solid waste pollution is a critically important element on surface and ground water leachate and runoff, air pollution associated with green house gases including methane and carbon dioxide are creating a socio-economic burden. Urbanisation and associated health costs are considered major issues, hindering development.

Now, how can we move forward to maintain sustainable development? The answer is not easy. Technical, financial, and social constraints and the absence of reliable database information and communication frameworks all need to be addressed. Short-term thinking and complex bureaucracy must be dealt with. Unless we admit and accept the need for change, moving forward will be a difficult task. As observed by the author and confirmed by many national and international monitoring agencies, the last decade witnessed a movement in the right direction by the government and pubic opinion. The establishment of many vital projects such as As-Samra Buil ‘Operate Transfer Project’ (BOT), Al-Gabawi landfill, Swaga hazardous waste project (TSDF) and the Ministry of Environment, in addition to the establishment of many research and academic institutions, are all real witnesses to development. However, movement on policy and the enforcement of regulations as well as the development of energy policy are lagging behind. Moreover, community involvement and awareness are extremely important factors in water and wastewater management and usage; as recycling, waste minimisation and recovery projects are also essential. National infrastructure management and clean technology applications are essential to maintain sustainability. The result of inaction will not only impact upon the environment but also the country’s economy.

A study by the World Bank in 2000 indicated that the cost of environmental degradation was 2.2-3.3 % of Jordan's GDP and a 1.0% of GDP as damage cost to the global environment (WHO, 2000). The questions remain; are these costs necessary? Can they be reduced or avoided? Will they in turn hinder the movement toward sustainable development?

CONCLUSION

An overall integrated management of natural resource exploration, usage, conservation and environmental protection in addition to national planning, infrastructure and clean technology applications must be introduced.

Identifying obstacles and accepting the need to change policies, ideologies and the adaptation of long-term quantifiable strategies are essential for sustainable socio-economic development. Technology transfer and benchmarking against successful sustainable development programs of developed countries could not be achieved in the absence of the aforementioned recommendations.

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