RESEARCH ARTICLE

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Status, Restrictions and Suggested Approaches in Wastewater Management in Rural Areas of Iran

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Aims of the Study: The objective of this study was to appraise wastewater management approaches in rural areas of Iran, restrictions, effects on environment and also definition of suitable management approaches in wastewater for future.

Materials & Methods: This descriptive study was performed in 2010 in rural areas of Iran. A questionnaire was prepared with subjects such as available management approaches on wastewater, suggested approaches on collecting wastewater and its final disposal and was sent to rural area's wastewater companies in each province. Study results of 4588 rural areas of Iran (with above 200 families) were collected. Results were analyzed using mean and percentage.

Results: The current available management systems were mainly based on absorption wells. The main problem in this system was high ground water levels, and low permeability of soil. The most important current problem of the absorbing wells was considerable damaging effects on surface and ground water.

Conclusions: The current wastewater management in rural areas especially in the field of wastewater collection was improper and undesirable. To overcome the current problem, it is necessary to use collecting methods relative to that of region. Considerable attention is required for the application of reused wastewater in agriculture.

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Background

Proper water and wastewater management approaches necessary for human health and development are among controversial issues in many countries. Although, water supply and wastewater management in industrial countries have been promoted to a standard manner, in low income countries the problem currently exists (1).

In most low and middle-income countries, a great deal is considered only to water supply and health is in later parts of attention. This is due to more preference of water supply compared to sanitation (priority of direct to

indirect benefits) (2, 3). Therefore, it appears that in low and middle-income countries wastewater management is frequently low on the list of national priorities (4). Wastewater management system includes collection, treatment, and reuse or effluent and sludge disposal (5). This system is required due to several reasons: 1) public health and welfare protection of community, 2) Water resource and environment protection, and 3) reuse of effluent due to the lack of water (6, 7).

Wastewater management (sanitary treatment and disposal) is ignored in many of low and middle-income countries especially in their rural areas. The main reason is that governments usually precede urban areas (8). Other reasons are relative high cost of construction, operation and maintenance of wastewater collection and treatment systems (6) and also, due to the other features of rural areas such as hard topography and climates, being far from urban areas (9). Therefore, there are more problems in water and wastewater management in rural areas when compared to urban areas, and most of countries put high priority on their projects in urban areas (6, 10).

According to statistical data obtained from Iran's population in 2006 (69.9 million), 31% (21.6 million) are living in 68000 rural areas. Totally, 5000 of these rural areas have population more than 200 families (approximately 1000 people) (11). The population index receiving safe drinking water in Iran was 69% in 2006. Only 0.6% of total rural areas population is covering water and wastewater services. The first and second integrated programs implemented in country, the wastewater status of 465 and 340 rural areas have been studied. In 25 rural areas of country wastewater, collection and treatment programs are in progress (12). Ministry of Energy and Water and wastewater companies are responsible for implementation of these programs (12). To achieve purposes mentioned above, the first step is implementation of an integrated survey of status of wastewater in rural areas.

Aims of the Study: The objective of this study was to appraise wastewater management approaches in rural areas of Iran, restrictions, effects on environment and also definition of suitable management approaches in wastewater for future.

Materials & Methods

This descriptive study was performed in 2010 in rural areas of Iran We prepared a questionnaire with subjects such as available management approaches on wastewater, suggested methods on collecting wastewater and its final disposal and sent it to rural area's wastewater companies of each province. Totally, 4588 rural areas of Iran (with above 200 families) involved. Some of the related information included:

- Current available approaches in collection, treatment, and disposal of human wastewater (toilets);
- Current available approaches in collection, treatment, and disposal of sanitary wastewater (gray water);
- Effects of current disposal approaches on environment, health and economy;
- Suitable suggested approaches for wastewater collection in rural areas;
- Suitable suggested approaches for wastewater treatment in rural areas;
- Suitable suggested approaches for wastewater reuse or final disposal in rural areas;
- Restrictions in the construction of wastewaters plants in rural areas;
- Restrictions in the construction of sewers in rural areas.

Since questionnaires of some of these rural areas had been left without answer, therefore, they were ignored.

Data analysis: Results were analyzed using Microsoft Excel software 2007 for calculating central statistical (mean and percentage).

Results

The results of questioners were categorized into three sections including of current status of wastewater management, restrictions and proper methods of wastewater management on future.

Status of wastewater management: Human wastewater (toilets) is managed separately from sanitary wastewater in many parts of rural areas of Iran. Current available approaches in human wastewater disposal include absorption well (in 66% of rural areas with population more than 200 families), septic tank (in 3.9% of rural areas with population more than 200 families). It should be noted that sewer systems are available only in less than 0.6% of rural areas. Sewers with other using management approaches are available in 2.3% of these rural areas (Table 1). The current available approaches in sanitary wastewater management are somewhat different from that of human wastewater management.

Sanitary wastewater is usually disposed in absorbing wells (19.2% of rural areas), discharging to curbside canals (2.9%), or dumping in unsanitary manner (4.4%) (Table 2).

In 4.9% of rural areas, the only management approach was wastewater application in green spaces and gardens. Only 0.5% of the rural areas have sewers for sanitary wastewater (gray water) (Table 2).

Current restrictions to wastewater management: The main restrictions exist in construction of sewers in the rural areas of Iran (population above 200 families) which include bad slopes of land and its direction (23.9%), unsuitable nature of land (texture of soil) (15.9%), high ground water level (13.8%), and land terrain (12.7%) (Table 3).

In addition, there were restrictions in the construction of wastewater plants the majority of which include: lack of land availability (19.6%), unsuitable climatic conditions (15.6%), and high level of ground water (13.8%), unsuitable nature of land (11.5%) and land terrain (10.2%) (Table 4). Current wastewater management approaches have caused limitations, and environmental and economical effects.

Some of the major problems include the probability of resource water contamination during rainy and snowy periods (45.2%), damage to sightseeing of land (33.5%) and contamination of rivers (2.81%). From economical view of point, 12.9% of the rural areas require high costs due to the high frequency of evacuation of cesspools, seepages pits, and Septic tanks (Table 5).

Desirable status of wastewater management: In order to improve current status of wastewater management, in 18.5% of rural areas wastewater should be collected conventionally, 17.7% use of sanitary wastewater be disposed in absorption wells and 16.1% small diameter gravity sewer systems (Table 6) be used. Furthermore, use of sewer is not required in 13.2% of these rural areas and on site disposal of wastewater is reliable (Table 6).

Current available treatment approaches of wastewater are nearly enough for 17.1% of the rural areas and in 11.7% of rural areas by improving these systems the new systems are not required (Table 7). However, it is required that septic tank with complementary treatment, and natural treatment be used in 26.8 and 19.2 percent of rural areas, respectively (table 7).

To achieve desirable status in wastewater reuse or its final disposal, it is required that 72.3% of the rural areas should use effluent in agriculture (Table 8). Wastewater reuse is not feasible in 9.1% of these rural areas and it is discharged improperly (Table 8). In 6.1% of these rural areas, the wastewater is discharged into seasonal streams or rivers (Table 8).

Table 1) Current collection and disposal approaches in human (toilets) wastewater

Number	Type of Approach		Number of Rural Areas	Percentage
1	Absorption Wells	Absorption Wells	3068	66.87
		Absorption Wells+other methods	1160	25.28
2	Septic Tank	Septic Tank	178	3.87
		Septic Tank+other methods	980	21.36
3	Sewer	Sewer	26	0.56
		Sewer+other methods	107	2.33
4	Discharge to Environment	Discharge to Environment	25	0.54
		Discharge to Environment+other methods	578	12.6
5	Without Answer	--	97	2.11

Table 2) Current collection and disposal approaches in sanitary wastewater (gray water)

Number	Type of Approach		Number of Rural Areas	Percentage
1	Absorption Wells	Absorption Wells	883	19.24
		Absorption Well+other methods	2388	52.04
2	Septic Tank	Septic Tank	37	0.8
		Septic tank+other methods	264	5.75
3	Sewer	Sewer	24	0.52
		sewer+other methods	207	4.51
4	Curbside Canals	Curbside Canals	132	2.87
		Curbside Canals+other methods	1349	29.4
5	Discharge into pathways, alleys, *ect*.	Discharge into pathways, alleys, *ect*.	201	4.38
		Discharge into pathways, alleys, *ect*.+other methods	2073	45.18
6	Green Spaces & Gardens Irrigation	Green Spaces & Gardens Irrigation	86	4.87
		Green Spaces & Gardens Irrigation+other methods	1336	29.12
7	Without answer	--	148	3.21

Table 3) Restricting factors in construction of sewer in rural areas

Number	Restricting Factor	Number of Rural Areas	Percentage
1	Texture of soil	693	15.10
2	Land terrains(mount, river and roads)	583	12.72
3	Slope and its direction (having multi slopes or very high and low slopes)	1097	23.91
4	Problems in transport of materials and machineries due to the unavailability of proper roads	107	2.33
5	Dispersed households and Residents	537	11.70
6	High fluctuation in quantity wastewater due to tourists and seasonal population	107	2.33
7	Pathways or streets are narrow (width is less than 2-3 m) Or may have many meanders	266	5.80
8	High level of ground water (lower than 5 meters)	635	13.84
9	Low quantity of wastewater	30	0.65
10	Others	125	2.72
11	Without answer	408	8.9

Table 4) Restricting factors in construction of treatment plants in rural areas

Number	Restricting Factor	Number of Rural Areas	Percentage
1	Lack of available land for construction of treatment plant	899	19.6
2	Nature of land (for example being rocky or stony)	528	11.5
3	Land terrains (mount, valley or river)	466	10.15
4	Problems in transport of materials and machineries due to the unavailability of proper roads	135	2.94
5	Regional climate restrictions and severe cold in autumns and winter	729	15.89
6	High fluctuation in quantity wastewater due to tourists and seasonal population	124	2.70
7	High level of ground water (lower than 5 meters)	618	13.47
8	Low quantity of wastewater	42	0.91
9	High necessity of treatment efficiencies (removal of nitrogen and phosphorus) which damage to receiving bodies of water	119	2.60
10	other	151	3.3
11	Without answer	777	16.93

Table 5) Current effects of wastewater management on environment, health, and economy

Number	Type of Effect	Number of Rural Areas	Percentage
1	High probability of surface resource contamination due to rain and snow fall	2076	45.25
2	Contamination of permanent rivers	806	17.56
3	Contamination of seasonal rivers	980	21.36
4	Contamination of beaches and sea	129	2.81
5	Contamination of spring and qanat waters passing through rural areas	859	18.72
6	Contamination of ground water (the bottom of cesspools and seepage pits have a distance lower than 3 m to ground water level)	648	14.12
7	Contamination of resources supplying water of rural areas (well, qanat and spring)	562	12.25
8	The waterborne diseases exist in rural areas	477	10.40
9	Damage to sightseeing of land	1543	33.53
10	High cost due to high evacuation frequency of cesspools, seepages pits and Septic tanks	592	12.90

Table 6) Proper suggested approaches in wastewater collection in rural areas

Number	Collection Method (first priority)	Number of Rural Areas	Percentage
1	Sewer is not required (disposal is onsite)	607	13.23
2	Disposal of septic wastewater in well and use of sewer for collection sanitary wastewater	810	17.65
3	Wastewater collection by use of SDGS	737	16.06
4	Wastewater collection using SS	562	12.25
5	Wastewater collection using conventional methods	849	18.50
6	Wastewater collection using combined methods (SS and SDGS systems)	412	8.98
7	Others	1	0.02
8	Without answer	610	13.3

Table 7) Proper suggested approaches for wastewater treatment in rural areas

Number	Treatment Approach (first priority)	Number of Rural Areas	Percentage
1	Current system is enough (absorption well) and construction of treatment plant is not required	782	17.05
2	Sanitation of available status (use onsite system)	536	11.68
3	Use of central septic tank+complementary treatment methods	1230	26.80
4	Natural systems	883	19.24
5	Reactor treatment t systems	59	1.28
6	Connect (discharge) to urban sewers	143	3.11
7	Combining to other rural areas	157	3.42
8	Use of a septic tank for each family+sand filter	19	0. 41
9	Different	2	0.04
10	Without answer	777	16.93

Table 8) Proper suggested approaches for reuse or final disposal of wastewater in rural areas

Number	Reuse or Final Disposal	Number of Rural Areas	Percentage
1	Reuse in agriculture	3319	27.34
2	Discharging on land without any control	418	9.11
3	Discharging into permanent rivers without any control	178	3.88
4	Discharge into seasonal rivers and agricultural drainage	282	6.14
5	Discharge into sea and lakes	23	0.5
6	Without answer	368	8.02

Discussion

Currently, sanitary wastewater (gray water) is managed separately from human wastewater in rural areas and its disposal is somewhat different. The reason is that these two wastewaters are different in nature from each other and the sanitary one has lower health problems compared to human wastewater. The available current status demonstrates that the most common management approaches are absorbing wells and septic tank and that sanitary wastewater usually is being disposed in absorbing wells or being discharged into pathways and curbside canals. Moreover, there are restrictions in current wastewater management in rural areas (with more than 200 families). For example, the main reason for unsuitability of current sewer systems and disposal approaches (absorption well) include, high ground water level (30%), low permeability of soil (24%) or land with stone and hard to excavate. The current improper wastewater management approaches has led to the problems such as environment pollution (water resource pollution and damage to sightseeing of land), health (cause waterborne diseases) and economy (high costs due to the evacuation of cesspool). One of the main controversial problems in the field of current wastewater management is the low number of rural areas having sewers.

As noted above, only 0.6% of rural areas are receiving wastewater collection and disposal services. In countries such as Bosnia, Herzegovina and Romania 10% of rural areas have sewers (13, 14) and in Poland 73.5% of rural areas have sewers (15).To improve current management status in rural areas of Iran, sewers are necessary. As defined in developmental programs by government, the numbers of rural areas, which will be receiving sewers, should be increased 30% by the end of 2025 (12). To achieve the purposes, proper suggested approaches are duplicated system (absorbing

wells for septic wastewater and sewer for sanitary wastewater, Small Diameter Gravity Sewer system, and separate systems. In decentralized wastewater management systems, on-site systems are smallest part and are used in residents and hospitals.

The most important onsite treatment of wastewater in rural areas of Iran are 1) Septic tank followed by complementary treatment 2) natural treatment of wastewater (including stabilization pond and wetland) and 3).Absorption wells. In rural and remote areas of Turkey, most of wastewater management approaches are septic tank, absorption wells, and packaged systems (16). Since effluent from septic tank is heavier in pollution compared to conventional treatment effluent and can cause several problems such as environmental and ecological pollution, therefore considerable care is needed (10). Wetlands are affected by climatologic limitations. Therefore, it is necessary to study the different related conditions of region before implementation. Several studies have shown if treated wastewater is managed properly, it can be used to overcome some of the growing problems of lack of water (17). Since a considerable amount of water is being used for agriculture in rural areas, so, it can be used as a source of water. Therefore, the main strategy in most of rural areas of Iran is reuse of treated wastewater in agriculture field.

Conclusions: The dominant wastewater management approach in rural areas of Iran is absorption wells and sewers which are used only in small number of rural areas. The current management approaches have contaminated surface and groundwater resources. The future priority in wastewater management of rural areas of Iran is based on sewers and septic tanks and natural treatment systems are in the next priority. In the field of wastewater management in rural areas of Iran, reuse of treated wastewater is very important and there is potential for wastewater reuse in agriculture.

In general, the current wastewater management in rural areas especially in the field of wastewater collection is improper and undesirable. To overcome the current problem, it is necessary to use collecting methods relative to that of region and a considerable attention is required for the application of reused wastewater in agriculture.

Footnotes

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Conflict of Interest:
The authors declare no conflict of interest.

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