Chapter 1
Wastewater Problems in Rural Communities, Their Influence on Sustainable Management in Protected Areas

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Abstract Managing wastewater treatment is a valuable alternative for water resource depuration and reuse in small rural communities. This is actually a common practice and is being implemented in territorial planning, based on sustainable use of the diverse systems. Despite the advantages and positive experiences obtained by the use of these techniques in small human settlements, its influence as criteria to evaluate the effectiveness of the natural spaces management can be understood by the administration and management team as a healthy indicator of the ecosystems coming from "secondary effects and reactions". This paper presents methodological bases for the union of wastewater management as a key factor for standard procedures for protected areas, taking into account the phases of diagnostic, normative, programmatic and cartography.

Keywords Ecosystems • Wastewater treatment management • Natural depuration systems • Spain

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H. Farfán González et al. (eds.), *Management of Water Resources in Protected Areas*, Environmental Earth Sciences, DOI 10.1007/978-3-642-16330-2_1,

1.1 Introduction

Water as a natural resource is an element of major importance for the physical environment as well as for the individuals who live in it. Water controls a majority of the processes that occur in nature, shapes the landscape, is essential for the survival of living beings, regulates the natural cycle of ecosystems, and interacts with a majority of abiotic elements that intervene in the conservation of protected spaces. As a management element, wastewater generated from any source where human activity exists may produce severe damage to natural systems. Therefore, measures have to be taken to avoid environmental problems. A sound water management procedure allows for the preservation of natural ecosystems in optimal conditions for which natural depuration techniques are of great value.

The proposition presented by this paper does not pretend to modify the actual standard methods, but attempts to complement it by adding new procedures to the process of decision making regarding wastewater management.

1.2 Environmental Advantages of Natural Depuration Systems (NDS) Over the Conventional Techniques of Waste Water Treatment

Natural Depuration Systems (NDS) comprise multiple environmental benefits compared to conventional or intensive treatment systems, especially those used for wastewater treatment in rural communities that are closer to naturally protected territories. Among those benefits, the most important are (de Armas et al. 2006):

- Low energy consumption
- CO_2 absorption
- Landscape integration
- New habitats for flora and fauna
- Low sludge production
- Capacity of use products and by-products of the depuration processes like wood, ornamental or livestock feeding species for their later sale (Salas et al. 2006)
- Some other advantages are considered such as the potentiality for environmental education. These facilities are often supported by many people due to the environmental services associated with its function.

According to Zavala (2006), water resources, soils, geology and geomorphology are features that were not incorporated into the guidelines to select sites for conservation, nor integrated into the Management Programmes of the Protected Areas. Therefore, it is necessary to include the abiotic elements as key factors for the management of protected spaces. The use of soils and water should be regulated to avoid negative effects on the biodiversity of the zone.

Wastewaters are usually the cause of severe sanitation problems in rural communities due to the economic constraints that limit the application of appropriate measures (Nogueira et al. 2006). NDS also encompass environmental disadvantages, such as the eutrophication of water reservoirs, producing a spectacular bloom of aquatic vegetation, when the design for the NDS is not appropriated or the terms of operation are violated. Usually excess water discharged into the system and the overload in terms of pollutant concentration is the limiting factors that cause system breakdowns. Another problem regarding the use of NDS is the land extension needed to implement the project.

Assuming Salas et al.'s (2006) statements, it can be summarized that NDS is an appropriate technique that can be extended to protected areas due to its economical, environmental and social benefits. From the environmental point of view, this wastewater treatment technique provides, along with water quality improvement, habitat conservation and perfect integration with the local environment. Regarding economic terms, it reduces costs of implementation and management. Socially speaking, the fact that constitutes a source of local employment and the facility may be of importance as a centre for environmental education for local inhabitants.

1.3 NDS Integration with the Management of Protected Spaces

As appointed by Salas et al. (2006), NDS provide services for decentralized management of wastewater, which are possible sources of other resources for the rural environment if included in the production cycle as an alternative for agricultural activities by turning wastes into agro fertilizers and other purposes.

Most of the protected spaces, no matter its management category, include certain regulations that lead to the conservation of the main natural resource. Those spaces with more strict regulations, such as public use, the presence of human settlements and the existence of economic and social activities, are almost absent. Some others include recreational possibilities as well as the development of activities related to the sustainable management on the local environment; nevertheless, it is less probable that both spaces are not affected by the negative impacts of wastewater flowing out to the neighboring communities.

Yet NDS, as an alternative for wastewater treatment, offers interesting environmental services; the management of the existing capacities in rural settlements associated with protected areas is usually a local or state government or a competition of private agencies.

Although there is proper operation of these technologies, only in fewer occasions the administrations in charge of protected ecosystems make use of them in their management plans. In this sense, the water resource should be evaluated not only

Table 1.1 Proposal for the diagnostic stage

Methodology for the management plan compilation (Cuba)	Proposal for NDS use
I. Diagnostic stage	
1. Description of natural conditions	
Brief description of the territorial context	Identification of water and waste water problems. Types of treatments. Operation conditions. Plans for new facilities for waste water treatment
2. Natural resources	
Geology	Description of the main tectonic features that may influence water dynamic
Climate	Bioclimatic features
Hydrology and oceanography	Hydrogeological features. Rock properties, types and distribution of the aquifer, water recharge and discharge, irrigation and flooding areas, pollution vulnerability
Soils	Hydrological properties of soils permeability, porosity, water retention coefficient and soil depth
Biodiversity	Aquatic flora. Water and water dependent fauna
Landscape variety	Description of aquatic habitats and there conservation
3. Socio-economic features of the area and surrounding	
Description of the economical bases	Water supply system dedicated to industry, agriculture, livestock and other services. Waste water discharge
4. Selection of conservation target	
Significance	Characteristics of water resource directly related to conservation objectives
Peculiarity	Characteristics of water resource as unique conservation object
Threat level	Evaluation of the threats affecting the quality of water resource
Conservation characteristics	Water significance as object of conservation
5. Water problems identification	
Environmental problems	Water related problems
Management capacity of the area	Identification of management capacity of the area
Economic and social issues	Water related problems: quality, supply, treatment
Analysis of research needs to support planning and management	Determine needs for information regarding water, water treatment and reuse
Synthesis of the problem	Description of current water problems as a key element of conservation

because of its natural value, but also to keep it from contamination to maintain ecological integrity.

Table 1.2 Proposal for the normative stage

Methodology for the management plan compilation (Cuba)	Proposal for NDS use
II. Normative stage	
Limits and category of the protected areas	Physical and socio-economical issues related to water problems
Objectives of the management plan	Set objectives with the aim of water resource management
Zoning and regulations for the use of the area	Zoning and regulating water resource
Conservation zone	No intervention on water resources admitted
Public zone	Obligation of using natural depuration systems compatible with the management category
Cultural and historical zone	Enhancement and promotion of the traditional usages of water resources
Zone for genetic resources	Prohibition of human intervention
Restoration zone	Regulation of water pollutants
Administrative zone	Meet the water standards
Socio-economic zone	Regulate the use of chemical and organic substances
Buffer zone	Keep close control on pollution sources
Marine zone	Meet the water standards

1.4 Proposal to Incorporate NDS to the Management Plans for Protected Spaces

Based on the methodology to compile the Management Plans for Protected Areas in Cuba (Gerhartz et al. 2008), and considering the priority attention to water resource conservation, some methodological bases are proposed to include wastewater management as a key element for the protected areas' official documentation.

These bases are not meant to replace any normative document that actually regulates the management of protected spaces. The intention is to include at every step of the current methodology the wastewater issue and the existing variety of techniques for wastewater treatment, without modifying the content and formality of the current procedures.

1.4.1 Some Proposals to Establish the Methodological Bases

- DIAGNOSTIC STAGE: Normally, during this phase the water resource is taken into consideration as a specific section: Hydrology and Oceanography, although it is possible to integrate a group of elements that simplify a detailed description about natural water and wastewater characteristics, attention must be paid to

Table 1.3 Proposal for the programmatic stage

Methodology for the management plan compilation (Cuba)	Proposal for NDS use
III. Management plans	
1. Protection programmes	
Surveillance and protection programme	Set surveillance systems for water resource control and installed depuration systems
Fire protection programme	Protection of water supply sources
Plans against disasters	Control over zones with potential risks, danger and vulnerability to water related disasters
2. Resource management programmes	
Forest management plan	Identify actions for water resource conservation
Management plan for species, habitats and ecosystems	Identify vegetal species compatible with NDS
3. Public use programmes	
Tourism programme	Integrate NDS wastewater stations into visits
Programmes for information, education and interpretation	Introduce activities related to water conservation, use, depuration and reuse
4. Programmes for scientific research and monitoring	
Research programme	Carry out research about water quality, ecosystem conservation and vulnerability
Monitoring programme	Set monitoring network
5. Administration programmes	
Administration programme	Create infrastructural, personal and resource capacities
Programme for compilation and actualization of management plans	Water issues have to be permanent and high-priority
Signalization programme	Introduce signals along natural water bodies, water springs and NDS facilities
Training programme	Include water subjects at every training activity
Public relation programme	Set partnerships on water management
Maintenance programme	Define actions for infrastructure maintenance
Investment programme	Declare explicitly the investments to be carried out in relation with water management

their natural values and socio-economic and cultural features of the sites. Using all this information, a varied description of the current water situation in the area is made, including its potential use and the environmental problems concerning water management (Table 1.1).

- NORMATIVE STAGE: It is important at this stage, to integrate all possible aspects to fulfill current regulations in the country, especially those related to protected spaces, as wastewater is a key element for the management of protected areas. Regulation for the use and actions regarding water resources must be specifically addressed to provide a safe and stable water resource. A sound area zoning must be performed to include any harmful factors (Table 1.2).

- PROGRAMMATIC STAGE: Once this stage is concluded, the ending point of the management plan, it is important to consider the potentialities of each programme in order to integrate activities and actions towards a sound water resource management, whether it is for conservation purposes as a natural element or for later reuse as is shown in the next table (Table 1.3).
- CARTOGRAPHY STAGE: It is recommended at this stage to draw maps representing the diversity of elements related to water resource, such as Slopes, Geomorphological units, Hydrogeology, Aquifer vulnerability, Water pollution sources, Pollution risks, NDS location, and Groundwater protection zones.

1.5 Conclusions

The methodology proposed in this paper might constitute a useful tool for decision makers for the integration of Natural Depuration Systems (NDS), within the Management Plans. Wastewaters are the possible cause of the collapse at any average ecosystem, especially those in rural and conservation areas.

Although NDS are managed by foreign institutions, private or public, data of the results derived from its operations must be part of the management and planning in protected areas.

This proposition will be more complex in those places where a karstic component of the substrate occurs, due to the complexity of the surface and groundwater karst systems.

Acknowledgments Project REAGUAM CGL2009-13168-C03-01 (Ministry of Science and Innovation, Spain), IMDEA-water Foundation (Madrid, Spain), and the General of Research Center and Environmental Services (ECOVIDA, Cuba)

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