In 1999, IWMI explored the advantages and risks of the use of urban wastewater for crop production along the Guanajuato river. At least 140 hectares of land downstream of the city of Guanajuato, farmers in two periurban communities (San Jose de Cervera and Santa Catarina) irrigate with raw wastewater. The benefits from wastewater irrigation include additional water, nutrients and the benefit obtained for the treatment (Scott, et al., 2000).

The Impact of a Treatment Plant on Wastewater Irrigation in Mexico

The 1996 Mexican environmental regulation NOM-001-ECOL establishes the maximum amount of contaminants permitted in wastewater discharged into public water bodies or national property. This restriction aims to reduce wastewater disposal into the river and the negative impacts for health and the environment, through a fine of US $0.25 per cubic metre of untreated water that exceeds the permitted limits. However, the regulation also leads to a reduction in the nutrient values and forms a constraint to irrigation by wastewater. In accordance with this regulation, the public water-supply company of Guanajuato city, called SIMAPAG, constructed an activated sludge wastewater treatment plant, which started to operate in June 2002. In this article, the plant’s benefits are reviewed. The aim is to give some preliminary answers to the research question: How does the water-treatment plant influence the benefits of the use of wastewater for crop production?

The need to assess these effects appears essential for future, since current national environmental laws and local policies will increase the volume of treated wastewater and actual will change the conditions of raw wastewater irrigation. In Guanajuato’s Hydraulic Plan for 2000-2025, an additional 47% of wastewater is planned to undergo treatment, which together with the 16% of wastewater already treated, makes for a total of 53% of treated wastewater in the near future.

The volume of residual waters generated in the 46 municipalities of Guanajuato total 207.13 million cubic meters per year. If this water could be used directly for agricultural purposes, it could irrigate around 20,500 ha, which is almost 5% of the actual irrigated land in Guanajuato (416,690 ha). There are 16 treatment plants in the urban areas and another 26 wastewater-treatment systems in the rural areas. The lack of technical and administrative capacity prevents the water treatment programmes from being carried out satisfactorily.

SIMAPAG and the Treatment Plant Project

Water supply for the city of Guanajuato (with a total population of around 106,000) is provided by SIMAPAG. There are 31 water-supply operator agencies like SIMAPAG in the state of Guanajuato. They act as financially autonomous public utilities with an independent administration. Only ten of these have a healthy financial status, but SIMAPAG had an outstanding performance in terms of financial surplus and overall efficiency (CEAG, 2001). The potable water-supply coverage is 95%, and sewer coverage 82%. Domestic connections represent almost 94% of the total number and there are very few commercial and industrial connections. The average production per connection is 27.7 m² and the average fee is US $0.59/m³ (CEAG, 2001).

SIMAPAG constructed an activated sludge with chlorine treatment plant. The federal government contributed 24% of the funds, the local government 40%, and SIMAPAG the remaining 36%. In , the plant treatment design parameters are described. According to the average production per connection, the expected sewage effluent from Guanajuato city is around 0.14 m³/s, this is a volume of 6.3 million cubic metres. Until the treatment plant started to operate, this effluent was discharged into the Guanajuato River. Nowadays, 70% is treated, while the wastewater produced by the community of Marfil, representing the remaining 30% of untreated wastewater, is seweraged downstream of the treatment plant outlet. Currently, SIMAPAG has to pay annually US $472,500 for this remaining 30% of untreated wastewater.

Water and Nutrient Value

The treatment plant gives SIMAPAG the opportunity to sell the treated water. No commercial transaction has taken place as of yet, but there will be greater competition among the different sectors. Moreover, raw wastewater irrigation will have to compete against the use of treated water, since every cubic meter of untreated wastewater disposed in the Guanajuato River costs SIMAPAG a fine of US $0.25.

Thus the farmers’ request to use raw wastewater will only arouse the interest of SIMAPAG if the farmers are willing to pay the fine expenses, which they cannot. The expected water productivity in small-scale irrigation systems is only around...
Table: Plant treatment design parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Influent</th>
<th>Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge design</td>
<td>Lps</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>Mg/l</td>
<td>217</td>
<td>&lt;60</td>
</tr>
<tr>
<td>Total Biological Oxygen Demand (BOD)</td>
<td>Mg/l</td>
<td>337</td>
<td>&lt;60</td>
</tr>
<tr>
<td>Total Nitrogen (Kjeldahl)</td>
<td>Mg/l</td>
<td>82</td>
<td>&lt;35</td>
</tr>
<tr>
<td>Faecal coliforms</td>
<td>MPN P/100 ml</td>
<td>6.2 X 10^6</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>Total Phosphorous</td>
<td>Mg/l</td>
<td>11</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>

Source: Aqua Orbi Ingenieros S.A. De C.V, 2001

US $0.15/m³ (Silva, et al., 2000). A higher productivity could be reached, even up to US $0.50/m³, if more profitable crops like vegetables are cultivated. But these vegetables are consumed raw, which is restricted under regulation NOM-001-ECOL-1996. The operation cost of one cubic metre of treated water is US $0.11. By means of a 10% charge for sanitation services, SIMAPAG recovers US $0.04/m³ from the domestic users and US $0.08/m³ from industrial and commercial users. In order to be profitable, the selling price for the treated wastewater should be at least US $0.07/m³. Industrial customers could pay up to US $0.50/m³, which would give a surplus of US $0.43/m³.

The existing concentration of nitrogen phosphorous in the effluent is enough to meet the nutrient requirements for alfalfa, the most common cultivated crop. Farmers show very little concern regarding the reduction of nutrients due to the water treatment process upstream, since the treated water still has a high content of nutrients. Water users are more afraid about water-level reduction in the river than about nutrient reduction in the river effluent. The sludge would represent another important source of nutrients.

The storage and elimination of this material is one of the major operational problems, while the area that could benefit from the waste-treatment plant is around 20 to 30% of the total study area. Unfortunately for the moment, the solid waste is taken to a landfill.

FOREGONE TREATMENT COST IMPACT

It is obvious that wastewater irrigation was not considered as an alternative method for wastewater treatment. The selection of the water-treatment process was entirely based on environmental regulation NOM-001-1996. The reason behind this is the great percentage of irrigated land without water entitlement. SIMAPAG only recognises the land that has a regular water right. Annually, this is worth US $0.15/m³ (Silva, et al., 2000).

Further research is needed to identify conditions under which the substantial benefits of wastewater irrigation can be captured while financial sustainability of the water-supply utilities is maintained. There are several aspects that need to be analysed regarding the relationship of the urban production of treated water and wastewater irrigation such as:

❖ a water market for treated effluent and its commercial feasibility in irrigation (comparison between the use of treated water and raw wastewater);
❖ water rights conflicts;
❖ hydrological impact of selling the treated water outside the sub-basin;
❖ water-quality assessment at the final use point (e.g., farm level for irrigation); and
❖ an accounting of nutrients lost from raw wastewater.

Notes
(1) Very often the state and its capital city have the same name in Mexico. Unless it is mentioned, Guanajuato refers to the province of Guanajuato and not to the city.
(2) SIMAPAG stands for Sistema de Agua Potable y Alcantarillado de Guanajuato in Spanish, or the “Guanajuato Water Supply System”.
(3) This figure comes from the assumption that 70% of the total produced water per outlet will be seweraged.

Nevertheless, if the produced treated water is not sold; the capital investment will not be justified. The cost and difficulty in operating and maintaining conventional treatment plants to meet the specified guidelines means that they are not recommended where wastewater storage and treatment reservoirs can be used (Blumenthal, et al., 2000).

CONCLUSIONS AND RECOMMENDATIONS

The major potential impact of the water-treatment plant is the possible reduction in wastewater discharge in the river, if the treated water is sold to an industrial consumer outside the Guanajuato River sub-basin. However, this would lead to competition over the water. The position of the farmers is weak because only 30 to 40 ha have proper water entitlement. This impact is not affected yet, because of additional sources of urban wastewater entering into the river downstream of the treatment plant.