

to correspond with the multifunctional nature of water. Furthermore, given the scale and complexity of river basin degradation, the federal and state levels of government often lack the operational capacity to address this type of environmental problem. This is where municipal governments can play a leading role, because it is precisely at the river basin level where the local government responds most directly to local demands and initiatives. When several municipal governments face common problems in relation to land management, due to the intersection of ecological and socioeconomic processes within watersheds that transcend administrative boundaries, it is of fundamental importance to increase institutional capacity for water resources management through inter-municipal arrangements, within the framework of integrated river basin management and/or integrated water resources management.⁽³⁾

Integrated water resources management (IWRM) has emerged precisely in response to the observation that water resources infrastructure and management have traditionally been developed for each water-related sector (such as irrigation, urban water supply, industry) independently, with no or little coordination between sectors. IWRM thus refers to the need to consider water in a more holistic way, by taking into account all aspects of water resources development, management and use, and the effects of these on each other, with a view to maximizing and reconciling the *economic, social and environmental* benefits of water use.⁽⁴⁾

The Global Water Partnership defines IWRM as:

“A process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.”⁽⁵⁾

In this way, IWRM promotes the integration of land and water management, the joint consideration and management of all water sources/bodies and aquatic environments, and it considers different water uses and users in conjunction. This, in turn, calls for a particular focus on upstream–downstream dynamics, as well as the adoption of more extensive physical, temporal and administrative boundaries than those used in conventional water project management: river basin limits rather than political divisions; longer-term timeframes to better coincide with the hydrological cycle and ecological processes, rather than electoral terms; and wider governance structures to encompass a broader range of actors that include water users as well as non-users.

The overall goal of IWRM is to strengthen water governance frameworks, and in so doing, improve the development, management and use of water. Strong emphasis is also placed on public participation, especially from women and low-income groups. A more integrated water governance framework does not necessarily imply the need for a centralized water resources ministry but, rather, an ability to plan, manage and use water in conjunction and in synergy where possible, and minimize conflicts among competing uses and users.

A range of different tools has been put forward to help achieve the objectives of IWRM. These include different institutions (e.g. river basin committees), regulations (e.g. pollution standards) and mechanisms (e.g. markets). However, other aspects are also important, including the scale at which decision making is structured, governance frameworks and

Biodiversidad de Occidente AC, Tenacatita 134, Autlán, Jalisco, CP 48900, Mexico; e-mail: sgraf@prodigy.net.mx.

Eduardo Santana Castellón is based at IMECBIO and specializes in wildlife conservation, avian ecology and the management of natural protected areas. He was a member of the original team that developed the technical proposal to create the Sierra de Manantlán Biosphere Reserve. He has acted as consultant to several national and international government agencies and NGOs, and has been recognized for his contribution to natural resources conservation in Mexico, and internationally.

Address: Instituto Manantlán de Ecología y Conservación de la Biodiversidad, Universidad de Guadalajara, Ave Independencia Nacional 151, Autlán de Navarro, Jalisco, CP 48900, Mexico; e-mail: esantana@cucsur.udg.mx.

Luis Manuel Martínez Rivera is a river basin management specialist based at IMECBIO. His work has focused on the prevention of water pollution, on riverbank restoration, and on the conservation and management of land and water, in particular in the Sierra de Manantlán Biosphere Reserve and the Ayuquila river basin. He is currently coordinator of the Inter-institutional Group for the Integrated Management of the Ayuquila River Basin.

Address: Instituto Manantlán de Ecología y Conservación de la Biodiversidad, Universidad de Guadalajara, Ave Independencia Nacional 151, Autlán de Navarro,

Jalisco, CP 48900, Mexico;
e-mail: lmartinez@cucsur.udg.mx.

Salvador García Ruvalcaba is a biologist and an environmental education specialist. He has been mainly concerned with ornithology, environmental education and eco-tourism in protected natural areas, and has been recognized for his contribution to natural resources conservation through environmental education. He is currently coordinator of the Environmental Education Programme for the Sierra de Manantlán Biosphere Reserve and the Inter-municipal Environmental Education Programme of the Ayuquila River Basin.

Address: Instituto Manantlán de Ecología y Conservación de la Biodiversidad, Universidad de Guadalajara, Ave Independencia Nacional 151, Autlán de Navarro, Jalisco, CP 48900, Mexico; e-mail: sgarcia_60@yahoo.com.mx.

Juan José Llamas is currently Deputy Director of the Sierra de Manantlán Biosphere Reserve, where he is responsible for institutional coordination within the Directorate. His work has focused on fostering development in rural communities within the reserve, and he has coordinated and implemented the Payment for Environmental Services Scheme (within the reserve), which aims to increase the conservation and protection of key zones, as well as various other government programmes. Since 2003, he has served as the secretary of the Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin.

implementation practice. The focus here is not solely on whether IWRM is implemented and with what mechanisms, but whether the chosen mechanisms are implemented in ways that are effective and compatible with the objectives of IWRM. For instance, decision making at the smallest appropriate scale is preferable, and decentralization has often been implemented for this purpose, but this will only be effective when accompanied by adequate financial resources, strong local capacity and an appropriate wider governance framework. Similarly, the creation of a river basin committee will be unlikely to lead to better basin management if it does not contain trained staff, or fails to include participation from all types of social actor in the watershed, thus running the risk of becoming monopolized by more powerful groups.

In practice, it is important to consider how this current international thinking on water resources management can be translated into practice, including how it can be financed sustainably, and how its impacts and effectiveness can be measured.⁽⁶⁾ In Mexico, municipal governments have initiated and consolidated important changes that have strengthened their capacity to formulate policies that are compatible with external development. In this way, they have undertaken internal restructuring that has enabled them to assume new responsibilities such as environmental management, they have adopted new processes for more efficient organization, and they have developed their human resources. All these improvements have fostered new forms of cooperation with the state and federal levels of government, as well as the local population.⁽⁷⁾

The aim of this paper is to present the experience of 10 municipalities in the central part of the Ayuquila river basin in western Mexico, which formed a collaborative association to attempt to improve the quality of life of their citizens and promote the more sustainable management of the water and other natural resources within and across their boundaries. Given the wide range of environmental problems faced in the Ayuquila river basin, and considering the central role of water resources, this paper adopts a broad conceptualization of IWRM and describes a strategy that is based on the principles that the governance of water resources should ensure the access of all watershed citizens to safe and adequate water, and that, recognizing that water can also be an economic good, the state should regulate water-based markets to prevent inequities and injustices generated by uncontrolled market forces.

Following this introduction, Section II presents the background of the region and its social and environmental problems, centering on the pollution of the Ayuquila River. These problems led to the creation of the Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin, which is described in Section III. Sections IV and V then proceed to outline the lessons, and challenges and limitations, respectively, of the initiative. Section VI ends with a concluding section reflecting on the future prospects of the initiative.

II. BACKGROUND

The Ayuquila-Armería River is one of the most important rivers in western Mexico, and its basin covers an area of 9,803 square kilometres in the states of Jalisco and Colima in western Mexico (Figure 1). The Ayuquila River rises in the upper basin and merges with the Tuxcacuexco River to

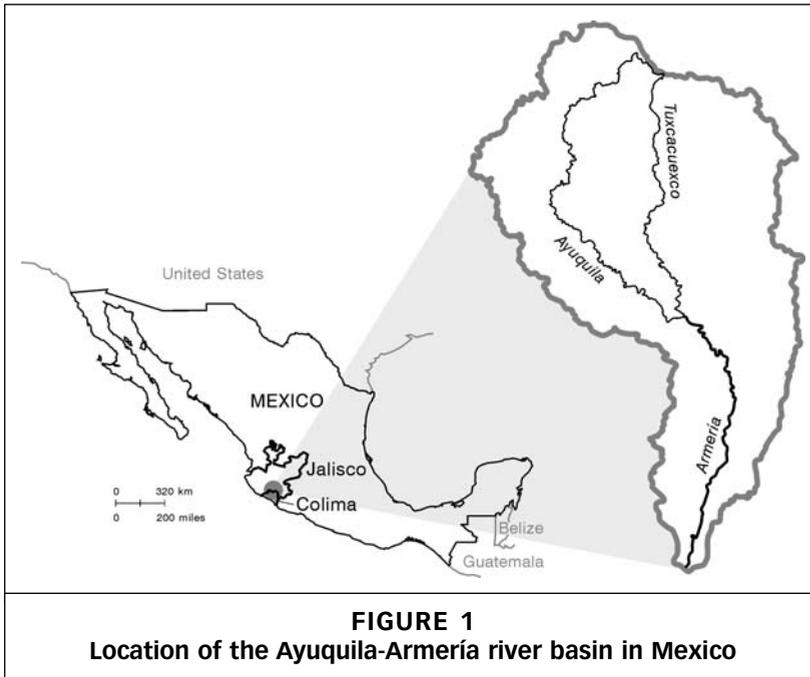


FIGURE 1
Location of the Ayuquila-Armería river basin in Mexico

Address: Dirección de la Reserva de la Biosfera Sierra de Manantlán, Comisión Nacional de Áreas Naturales Protegidas, Secretaría de Medio Ambiente, Recursos Naturales y Pesca, Prolongación Guadalupe Victoria 2760, Col Ejidal, Autlán, Jalisco, CP 48900, Mexico; e-mail: jllamas@conanp.gob.mx.

Acknowledgement: The authors would like to thank Jessica Budds from the School of Environment and Development, University of Manchester, who translated this paper from the Spanish original and reviewed and revised it. Thanks also to Graham Bowden, Cartographer, School of Environment and Development, University of Manchester, for producing Figure 1, and to Abby Hickcox, Department of Geography, University of Wisconsin-Madison for assistance with the figures.

its east to form the Armería River. It follows a southerly course for 294 kilometres through Jalisco and then Colima before discharging into the Pacific Ocean.⁽⁸⁾

Nationally, the water resources within the Ayuquila-Armería river basin are given high priority, because the basin contains five protected natural areas, a high diversity of native and threatened species and three large dams that provide water to irrigate 54,000 hectares of farmland in Jalisco and Colima. For a stretch of 71 kilometres, the Ayuquila River forms the northeastern boundary of the Sierra de Manantlán Biosphere Reserve (Figure 2), and also constitutes its most important aquatic ecosystem. This protected area forms part of the international network of reserves within UNESCO's Man and Biosphere programme. From a conservation perspective, the Ayuquila-Armería River harbours the highest biodiversity in Colima and the second highest in Jalisco. It contains 29 species of fish, two of which are endemic to the region; nine species of aquatic crustacean, one of which is endemic; and the neotropical (river) otter (*Lontra longicaudis*),⁽⁹⁾ which is listed in the World Conservation Union's (IUCN) 2006 Red List of Threatened Species.⁽¹⁰⁾

The initial amendment to Article 115 of the Mexican Constitution in 1983 marked the first serious attempt to decentralize power to the local level, by transferring the responsibility for drinking water, sewerage and wastewater treatment, as well as solid waste management among other functions, to municipal governments.⁽¹¹⁾ However, it was not until 1992 that Jalisco delegated the management of water, sanitation and wastewater treatment services to the municipal level.

Similar to many parts of Mexico, the key problem with drinking water supply and sewage disposal in the Ayuquila river basin is inadequate service provision. Drinking water supply coverage in urban areas

1. Santana Castellón, Eduardo, Sonia Navarro Pérez, Luis Manuel Martínez Rivera, Angel Aguirre, Pedro Figueroa and Cesar Aguilar (1991), "Contaminación, aprovechamiento y conservación de los recursos acuáticos del río Ayuquila, Reserva de la Biosfera Sierra de Manantlán, Jalisco-Colima", in *Tiempos de Ciencia* Vol 30, pages 29-38; also Martínez Rivera, Luis Manuel, Arturo Carranza and Micaela García (2000a), "Aquatic ecosystem pollution of the Ayuquila River, Sierra de Manantlán Biosphere Reserve, Mexico", in M Munawar, S G Lawrence, I F Munawar and D F Malley (editors), *Aquatic Ecosystems of Mexico: Status and Scope*, Ecovision World Monograph Series, Backhuys, Leiden, The Netherlands, pages 165-181; and Martínez Rivera, Luis Manuel, Eduardo Santana Castellón and Sergio Graf Montero (2002), "Una visión del

manejo integrado de cuencas”, Integrated Ecosystem Management Course, Colegio de Postgraduados, Mexico, 25 February–1 March.

2. Graf Montero, Sergio, Cesar Aguilar and Salvador García Ruvalcaba (1996), “The conservation and development of the Ayuquila River in the Sierra de Manantlán Biosphere Reserve”, modified version of a paper presented at the ACSP–AESOP Joint International Congress “Local Planning in a Global Environment” (translated by Daniel Schneider, edited by Eduardo Santana Castellón), Toronto, Canada, 25–28 July; also Graf Montero, Sergio, Eduardo Santana Castellón, Enrique Jardel Peláez, Martín Gómez and Salvador García Ruvalcaba (2003), “Vinculación social y arreglos institucionales para la gestión de las áreas naturales protegidas: el caso de la Reserva de la Biosfera Sierra de Manantlán, México”, in J Carabias, J de la Maza and R Cadena (editors), *Capacidades Necesarias para el Manejo de Áreas Protegidas en América Latina*, Nature Conservancy, Mexico; and see reference 1, Martínez Rivera et al. (2002).

3. Santana Castellón, Eduardo and Sergio Graf Montero (2001), “Iniciativa local para el manejo integral de la cuenca del río Ayuquila: contribución al Programa de Desarrollo Regional Sustentable (PRODRS) región Sierra de Manantlán”, unpublished report, Instituto Manantlán de Ecología y Conservación de la Biodiversidad, University of Guadalajara, Mexico.

4. Dourojeanni, Axel (2000), “Water resources and river basin management in Latin America”, United Nations Economic Commission for Latin America and the Caribbean (ECLAC), Santiago, Chile; also CAP-NET (2005), “Integrated water resources management plans: training

within the basin is slightly above the national average, at 94 per cent, compared with 89 per cent nationally; while rural coverage is slightly below, at only 64 per cent, compared with 70 per cent nationally (in the basin, 66 per cent of the population live in urban settlements and the rest in rural areas).⁽¹²⁾ Statistically, therefore, drinking water supply coverage appears to be good compared with the situation in Mexico as a whole. However, in practice, these figures are misleading, because domestic supply is very intermittent. In the municipalities within the basin, it is common for piped water to only be available for a few days per week, in which case the majority of households rely on storing water in elevated tanks. Unfortunately, no detailed and reliable local information exists to determine the true extent of these deficiencies in water supply.

In relation to sanitation, according to an assessment made by the Jalisco State Water and Sanitation Commission⁽¹³⁾ in 2001, not a single municipality met the environmental standards for wastewater treatment and disposal. In 1996, federal regulations dictated the timeframes within which urban centres of different sizes must install treatment plants. A deadline of 2000 was set for settlements with more than 50,000 inhabitants. However, in the Ayuquila basin, some towns of this size failed to meet the requirements, such as Autlán, which has just over 50,000 inhabitants but only installed its treatment plant in 2003; and the city of Villa de Alvarez in Colima state, with a population of more than 250,000 people, but which is only due to commence construction of its plant in 2007. For settlements of between 20,000 and 50,000 inhabitants, such as El Grullo and Unión de Tula, the deadline was 2005, yet none has built a wastewater treatment plant. Small towns with between 10,000 and 20,000 residents have until 2010 to install a treatment plant.

However, the construction of a treatment plant is only one step towards improving wastewater treatment standards. Towns in the basin that already have some type of wastewater treatment system face problems that are common throughout Mexico: insufficient resources for operation, limited coverage of sewage pipes and collection systems, inappropriate technologies, untrained staff, a lack of control over municipal sewage discharge, tariffs that are not cost-reflective and no attempts to reuse treated wastewater.⁽¹⁴⁾

In spite of the above, the control of water pollution in the Ayuquila River, from both industrial effluent and urban wastewater, was an important driver that impelled towns to consider environmental quality and to take action to address water pollution. This indicates that municipal governments are gradually making progress towards addressing the problem of wastewater treatment. However, the availability of detailed and reliable information about water resources in the region would better enable municipalities to define longer-term actions.

Over the last two decades, water pollution has been the main factor contributing to the degradation of the river in the central part of the basin, principally from the discharge of effluent from the local sugar industry, and untreated sewage from the larger urban centres in the region.⁽¹⁵⁾ Every year, during the sugarcane harvest season, the effluent from the Ingenio Melchor Ocampo sugar refinery used to kill a huge number of fish and crustaceans, which compromised the food sources of, and had serious health impacts on, the riparian communities in the municipalities of Tuxcacuesco, Tolimán and Zapotitlán de Vadillo, which are among the poorest in Jalisco. In addition to the effluent from the

sugar refinery, the towns of El Grullo and Autlán also used to discharge their untreated sewage into the river, which similarly affected both the biodiversity of the river and downstream communities.⁽¹⁶⁾

Given the economic importance of the Ingenio Melchor Ocampo sugar refinery as the principal source of employment in the region, and given that they do not bear the direct impacts of the pollution that flowed downstream, neither the municipalities of Autlán and El Grullo nor federal and state government authorities responded to complaints from local peasant communities about the pollution. Furthermore, the legislation in force contained many inconsistencies, which, in the 1980s, made it difficult to apply to prevent the pollution. The situation along the Ayuquila River was thus a classic case of environmental injustice, whereby the poorest communities living downstream of the sugar refinery bore the costs of the pollution, yet received few economic benefits from the industry and agriculture developed upstream. Furthermore, the Ingenio Melchor Ocampo sugar refinery refused to acknowledge that it was the source of the pollution that so negatively affected downstream communities each harvest season.

In response to the concerns of the riparian communities living alongside the Sierra de Manantlán Biosphere Reserve, who were affected by the pollution, in 1989 the Instituto Manantlán de Ecología y Conservación de la Biodiversidad (Manantlán Institute for Ecology and Biodiversity Conservation) (IMEC BIO) at the University of Guadalajara⁽¹⁷⁾ (also situated within the Ayuquila basin), undertook an environmental assessment of the situation and produced a set of guidelines for the clean-up of the river.⁽¹⁸⁾ Later, in 1993, the Federal Government created the Dirección de la Reserva de la Biosfera Sierra de Manantlán (Directorate of the Sierra de Manantlán Biosphere Reserve) (DRBSM) to administer the protected natural area from local headquarters. The DRBSM then created new institutional structures in the form of "Ayuquila River protection boards" that enabled the riparian communities to articulate their concerns.⁽¹⁹⁾ In these communities, the Federal Ministry of Social Development,⁽²⁰⁾ the Jalisco state government, the DRBSM and the various municipal governments also collaborated to develop a participatory planning process in order to define priorities for action towards poverty reduction. As part of this process, the communities identified the pollution of the river as the primary constraint to local development.⁽²¹⁾ Within the framework of the 1992 National Water Law, the new Ministry of Environment and Natural Resources⁽²²⁾ was created in 1995, which absorbed the National Water Commission,⁽²³⁾ the national agency responsible for water management, and the former Ministry of Fisheries.⁽²⁴⁾ This allowed the creation of a more integrated approach to water management in the country. The same year, the political party holding office in the Jalisco state government changed for the first time in the state's history, and the Ingenio Melchor Ocampo sugar refinery was privatized (it had previously been a parastatal company) as a result of economic policy changes at the federal level. The combination of these events formed a new institutional, legal and social context that facilitated the creation of new channels to tackle the problem of river pollution.⁽²⁵⁾

At the same time, a public campaign against river pollution was undertaken through the local, state and national media. IMEC BIO developed a research programme to collect and document evidence of the pollution that would support the complaints of the peasant

manual and operational guide", Capacity Building for Integrated Water Resources Management (CAP-NET), Delft, the Netherlands; GWP (2000), "Integrated water resources management", Background Paper No 4, Global Water Partnership (GWP) Technical Committee, Stockholm, Sweden; GWP (2004), *Catalyzing Change: A Handbook for Developing Integrated Water Resources Management (IWRM) and Water Efficiency Strategies*, Global Water Partnership (GWP) Technical Committee, Stockholm, Sweden; IADB (1998), "Integrated water resources management in Latin America and the Caribbean", Technical Study, Inter-American Development Bank (IADB), Washington DC; Rees, Judith (2005), "IWRM, water efficiency plans and urban water services", unpublished paper for the Technical Advisory Committee, Global Water Partnership, Stockholm, Sweden; United Nations-Habitat (2003), "Improving urban water and sanitation provision as part of integrated water resources management", in United Nations-Habitat, *Water and Sanitation in the World's Cities: Local Action for Global Goals*, Earthscan, London, pages 193-223; and United Nations-Habitat (2006, in press), "Integrated water resources management and the provision of water supply and sanitation to small urban centres", in United Nations-Habitat, *Water and Sanitation in the World's Cities 2006: Meeting Development Goals in Small Urban Centres*, Earthscan, London.

5. See reference 4, GWP (2004), page 22.

6. Moreno, Luis Alberto (2006), "Implementation of integrated water resources management", Paper presented at the 4th World Water Forum, Mexico City, 16-20 March.

7. Sánchez Bernal, Antonio (2002), "Las posibilidades del desarrollo económico local en México", Report based on a paper presented at the conference "Gobiernos Locales: El Futuro Político de México", Instituto Tecnológico de Estudios Superiores de Occidente, Guadalajara, Mexico, 23–24 September 1999.

8. See reference 1, Martínez Rivera et al. (2002).

9. Also known as the long-tailed otter or South American river otter.

10. See reference 1, Santana Castellón et al. (1991).

11. Moreno, Carlos (2004), "Fiscal performance of local governments in Mexico under decentralization: a political explanation", Paper presented at the Meeting of the Latin American Studies Association, Las Vegas, US, 7–9 October.

12. CNA (2001), "Estudio de disponibilidad y balance hidráulico actualizado de aguas superficiales de la región hidrológica Río Armería", Comisión Nacional del Agua, Mexico; also CNA (2005), *Estadísticas del Agua en México*, Comisión Nacional del Agua, Mexico.

13. Comisión Estatal de Agua y Saneamiento (CEAS).

14. Sandoval, Juan Martín (2000), "Compendio sobre el agua: un análisis temático para la introducción al quehacer legislativo", Comisión de Asuntos Hidráulicos de la Cámara de Diputados, Mexico.

15. See reference 1, Santana Castellón et al. (1991).

16. Graf Montero, Sergio and Jesus Rosales Adame (1995), "Diagnóstico sociodemográfico de la Sierra de Manantlán y su región de influencia", unpublished technical report, Secretaría de Medio Ambiente,

communities.⁽²⁶⁾ IMECBIO and the DRBSM documented the high levels of poverty and social marginality in the communities that lived along the river, and this served as the basis for expanding federal poverty alleviation programmes into the region. Both institutions also assisted communities to organize into "river defence committees", and prepare and submit formal complaints to the various government agencies responsible for environmental management, supported by physical evidence of pollution.⁽²⁷⁾ In addition, IMECBIO and the DRBSM developed a successful environmental education programme that raised awareness among communities living upstream of the biosphere reserve of the impacts that river pollution caused to peasant communities downstream. This programme formed the basis of what would later become the first successful municipal solid waste separation programme in El Grullo and Autlán.⁽²⁸⁾

Following the complaints from the riparian communities and the intensive awareness campaign on the impacts of river pollution, cleaning up the Ayuquila River was established as a public priority during the process of planning that accompanied the regionalization of Jalisco in 1997.⁽²⁹⁾ Then, in 1998, the National Water Commission established the Ayuquila-Armería River Basin Committee.⁽³⁰⁾ Despite the development of this increasing number of investment projects within the framework of regional development planning, the expectation that the creation of the Ayuquila-Armería River Basin Committee would solve the problem of river pollution rapidly faded, because the committee's primary concern was the distribution of water between the irrigation sectors of Jalisco and Colima. The committee made no progress whatsoever in addressing river pollution, even though this was the most pressing problem for the local population. Furthermore, the committee offered few opportunities for public participation, because it neither incorporated the municipal governments nor other users, such as the peasant communities living along the river.⁽³¹⁾

Finally, in 1998, a molasses tank ruptured in the Ingenio Melchor Ocampo sugar refinery causing the accidental release of a massive quantity of molasses into the river, which killed a huge number of fish and impacted low-income municipalities downstream in Jalisco and even in neighbouring Colima, more than 100 kilometres downriver.⁽³²⁾ The peasant communities, with the support of the municipal governments, staged protests against the sugar refinery. The crisis resulting from the accident finally forced the government authorities to act on river pollution. The refinery was fined and, through various sanctions that included its partial closure, it was ordered to change its effluent disposal system in order to completely eliminate the discharge of contaminated water into the Ayuquila River by 2000. These controls immediately produced a marked improvement in river water quality in the Autlán and El Grullo Valley (Figure 2). The improvements were also reflected independently in physical and chemical water quality parameters (including, for example, tests for dissolved oxygen and turbidity), the presence of different fish species, biotic integrity indicators relating to aquatic invertebrates, the frequency of otter sightings, and social surveys on perceptions of water quality carried out among the communities that lived in the irrigated farmlands downstream of the sugar refinery.⁽³³⁾

III. THE INTER-MUNICIPAL INITIATIVE FOR THE INTEGRATED MANAGEMENT OF THE AYUQUILA RIVER BASIN

Following the dynamism created by the success of limiting the effluent from the sugar refinery and the positive collaborative experience from the process of regional planning, the advantages of municipal governments working together to address shared problems, such as river pollution, became clear. Equally evident were the benefits of collaborating with local institutions, such as the DRBSM and IMECBIO, in order to obtain general support and technical advice. Partly due to these benefits, and partly due to the Ayuquila-Armería River Basin Committee's inability to induce a local process for river quality restoration or effective river basin management, other collaborative mechanisms were needed that were both flexible and more responsive to the concerns and initiatives of the local populations as well as other social and institutional actors within the basin. Although collaboration between IMECBIO and certain municipal governments dates back to 1988, based on the Directorate of the Sierra de Manantlán Biosphere Reserve Initiative, on 25 July 2001 eight municipal governments signed a letter of intent to formalize their commitment to the joint implementation of environmental management projects at the watershed level under the Iniciativa Intermunicipal para la Gestión Integral de la Cuenca del Río Ayuquila (Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin).

In August of the following year, a private trust fund was set up as a mechanism to finance the initiative, based on contributions from the Federal Ministry of Environment and Natural Resources, the Jalisco state government and the municipalities. The initiative subsequently expanded to incorporate another two municipalities in Jalisco, and now comprises Autlán, Ejutla, El Grullo, El Limón, San Gabriel, Tolimán, Tonaya, Tuxcacuesco, Unión de Tula and Zapotitlán de Vadillo.⁽³⁴⁾ The initiative covers an area of 4,100 square kilometres with a total population of 136,000 inhabitants (almost the size of the neighbouring state of Colima). The initiative is being developed in, and financed by, Jalisco. In Colima, an inter-municipal initiative comprising payments for watershed services – that is, the ability of watersheds to produce good quality and secure flows of water – is being developed in the lower (southern) part of the basin.⁽³⁵⁾ In the future, it is hoped that these local initiatives will be integrated in order to form a basin-wide initiative.

As a strategy to foster cohesion among the mayors of the municipalities involved, as well as to create a shared vision of the mission of the inter-municipal initiative, IMECBIO arranged at the start of each new political term of municipal government for the newly elected mayors to participate in learning workshops and a ten-day trip to the Credit river basin in Ontario (Canada) and to Wisconsin (United States). The trip allowed mayors to see an inter-municipal governance mechanism in action in the Credit Valley, and to compare notes with their North American counterparts about issues such as municipal drinking water provision, solid waste management, mechanisms for public participation, and river management for recreation and conservation.

The inter-municipal initiative is an innovative local governance mechanism for environmental management. However, despite its name, participation in the initiative is not restricted to municipal governments,

Recursos Naturales y Pesca and the Instituto Manantlán de Ecología y Conservación de la Biodiversidad, University of Guadalajara, Mexico; also see reference 2, Graf Montero et al. (1996); and see reference 1, Martínez Rivera et al. (2000a).

17. Guadalajara is the capital city of the state of Jalisco.

18. See reference 1, Santana Castellón et al. (1991).

19. García Ruvalcaba, Salvador (2002), "Reciclaje y saneamiento del río Ayuquila en la Reserva de la Biosfera Sierra de Manantlán", *Revista Da Vinci* Vol 4, No 99, pages 23–41; also see reference 2, Graf Montero et al. (1996); and Graf Montero, Sergio, Enrique Jardel Pelaéz, Eduardo Santana Castellón and Martín Gómez (2001), "Instituciones y gestión de reservas de la biosfera: el caso de la Sierra de Manantlán, México", in A E Toribio and C Soruco (editors), *La Investigación Interdisciplinaria en las Reservas de la Biosfera*, Secretaría de Desarrollo Sustentable y Política Ambiental, Buenos Aires, Argentina.

20. Secretaría de Desarrollo Social (SEDESOL).

21. See reference 19, Graf Montero et al. (2001).

22. Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT).

23. Comisión Nacional del Agua (CNA).

24. Secretaría de Pesca (1982–1994).

25. See reference 2, Graf Montero et al. (2003).

26. Henne, Lisa J, Daniel W Schneider and Luis Manuel Martínez Rivera (2002), "Rapid assessment of organic pollution in a west-central Mexican river using a

family-level biotic index”, *Journal of Environmental Planning and Management* Vol 45, No 5, pages 613–632; also Lyons, John, Sonia Navarro Pérez, Philip A Cochran, Eduardo Santana Castellón and Manuel Guzmán Arroyo (1995), “Index of biotic integrity based on fish assemblages for the conservation of streams and rivers in west-central México”, *Conservation Biology* Vol 9, No 3, pages 569–584; and see reference 1, Martínez Rivera et al. (2000a).

27. See reference 2; also see reference 16.

28. See reference 19, García Ruvalcaba (2002).

29. A process through which municipalities were grouped into regions, in order to form larger territorial units.

30. CNA (2003), *Estadísticas del Agua en México*, Comisión Nacional del Agua, Mexico; also see reference 19, Graf Montero et al. (2001); and see reference 1, Martínez Rivera et al. (2002).

31. See reference 2, Graf Montero et al. (2003); also see reference 1, Martínez Rivera et al. (2002).

32. Martínez Rivera, Luis Manuel, Eduardo Santana Castellón and Arturo Carranza Montaño (1998), “Informe sobre la derrama de melaza ocasionado por el Ingenio Melchor Ocampo el día 20 de marzo de 1998 y los resultados de los estudios y acciones complementarias”, Instituto Manantlán de Ecología y Conservación de la Biodiversidad, University of Guadalajara, Mexico, 28 March; also Martínez Rivera, Luis Manuel, Arturo Carranza Montaño, Angel Aguirre García, Georgina González, John Lyons, Daniel W Schneider and Lisa J Henne (1999), “Evaluación del impacto del siniestro ocurrido por la descarga de melaza del Ingenio Melchor Ocampo

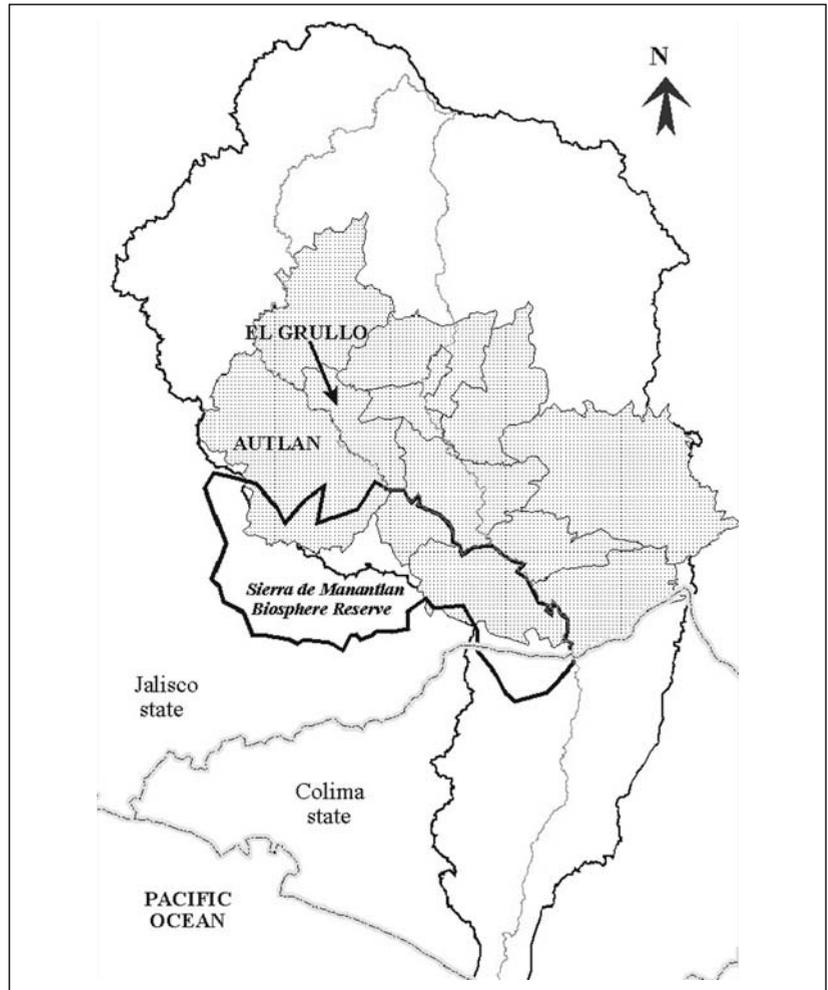


FIGURE 2
Area covered by the Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin (shaded)

but incorporates other institutions as strategic partners. These institutions comprise federal and state government agencies with a local presence, such as the Sierra de Manantlán Biosphere Reserve, which falls under the remit of the National Commission for Protected Natural Areas,⁽³⁶⁾ and the Jalisco State Rural Development Secretariat.⁽³⁷⁾ It also includes academic partners through IMECBIO (at the University of Guadalajara) and civil society representatives, such as the Fundación Manantlán para la Biodiversidad de Occidente (Manantlán Foundation for the Biodiversity of Western Mexico). The inter-municipal initiative has been formally incorporated into the Ayuquila-Armería River Basin Committee, which forms an interface with other regional actors, including Colima state government agencies.

The mission of the inter-municipal initiative is:

"To form an association of municipalities, which counts on the participation and support of local citizens, develops the institutional capacity to improve the standard of living of its population through effective environmental management, incorporates local initiatives, and receives coordinated support from the federal, state and municipal governments."⁽³⁸⁾

One particular objective is to professionalize municipal environmental management by employing specialist civil servants without affiliations to political administrations, in order to ensure the provision of good quality services to residents that are not disrupted by the transitions between the three-year political terms of office at the municipal government level. At a planning workshop, the initiative defined six strategic actions to address the environmental problems in the central part of the basin: spatial planning, public participation, strengthening the institutional capacity of local governments, solid waste management, restoration of the head-water of the Ayuquila River and environmental conservation in the upper part of the river basin.

One of the most complex problems that the initiative has faced is that of drinking water supply and wastewater treatment. In 2006, the initiative financed an assessment of the water situation in the basin, for which it aimed to obtain detailed information on the current extent of water and sanitation services in the urban areas. This assessment would enable towns to define their long-term water strategies, in order to ensure the supply of safe water, adequate wastewater treatment and conservation of groundwater recharge areas. Also during 2006, the initiative adopted the principle of water as a human right, in order to work towards access to this vital resource by the entire population within the participating municipalities. Furthermore, the initiative is seeking to fund one water kiosk in each town. The water kiosks will provide purified water of the same quality as bottled water, free of charge to those in need.

To date, the inter-municipal initiative has had a significant impact on the region made up of the participating municipalities, in terms of producing benefits for the inhabitants. Some of the specific results are as follows:

- The initiative has reduced levels of pollution from industry and urban areas in the Ayuquila River. This has improved both local economic conditions, through fishing for subsistence and small-scale commercial purposes, and public health, which, in turn, has directly benefited more than 15 riparian communities that depend on the river for their livelihoods.
- The implementation of municipal programmes for household waste separation and recycling has reduced the amount of solid waste produced and increased public awareness of environmental issues. It has also improved the cleanliness of urban areas and is likely to lead to savings in public spending, through longer useful lives for landfill sites and less space needed for solid waste disposal infrastructure. The various management set-ups of the solid waste-recycling centres also demonstrate innovation. In two cases, municipal governments administer the centres, another is managed in partnership with an entrepreneur, and a third is run by a peasant women's cooperative. In El Grullo, over half the population now separates and washes household waste, which has reduced the volume of solid waste produced in the municipality by nearly 60 per cent.

sobre el río Ayuquila, Reserva de la Biosfera Sierra de Manantlán", Instituto Manantlán de Ecología y Conservación de la Biodiversidad, University of Guadalajara, Mexico.

33. Martínez Rivera, Luis Manuel, Eduardo Santana Castellón, Luis Ignacio Iñiguez Dávalos and J Francisco Santana Michel (2000b), "Programa de acciones del Ingenio Melchor Ocampo para la restauración del río Ayuquila", Instituto Manantlán de Ecología y Conservación de la Biodiversidad, University of Guadalajara, Mexico.

34. See reference 19, Graf Montero et al. (2001).

35. Graf Montero, Sergio, Paola Bauche and Leila Wynter (2003), "Mecanismo de pago de servicios ambientales en cerro grande, Reserva de la Biosfera Sierra de Manantlán", MABIO AC, CCMSS and IMECBIO, Jalisco, Mexico.

36. Comisión Nacional de Áreas Naturales Protegidas (CONANP).

37. Secretaría de Desarrollo Rural del Estado de Jalisco (SEDER).

38. Iniciativa Inter-municipal para la Gestión Integrada de la Cuenca del Río Ayuquila (IIGICRA) (2004), "Memorias del taller de planeación estratégica ambiental municipal. Iniciativa Intermunicipal para la Gestión Integral de la Cuenca del Río Ayuquila", Autlán de Navarro, Jalisco, Mexico, 2–3 September.

- Greater public participation has been achieved through the organization of civil society groups and schools to clean up roads and to restore the headwaters of watercourses and the banks of the Ayuquila River. The environmental education programme implemented in 2003 reaches more than 10,000 people each year. A case of special note is the Ayuquila River Environmental Festival, during which the cleaner river water and banks have encouraged thousands of people to resume the custom of bathing in the river during Easter week. The improved organization of the municipalities and the environmental education programme has boosted the number of visitors to the festival from 4,200 in 2000 to 12,000 in 2005. In contrast, at the same time, the amount of solid waste per person has fallen to just 20 per cent of that produced in 2000.
- The inter-municipal initiative has increased social capital through the formation of civil society groups under the environmental education programme, comprising over 200 participants whose activities benefit the wider community.
- Improvements in the availability of information about environmental problems and their links with social and economic development at the municipal level has made citizens more active – but also more demanding – in devising responses to environmental problems within the region.
- Finally, the trust fund established with contributions from the federal, state and municipal levels of government has proved to be a successful and flexible financial mechanism, which has increased in value each year: from approximately 1 million Mexican pesos (US\$ 100,000) in 2003 to 4 million pesos (US\$ 400,000) in 2006 due to effective communication with the Jalisco state congress. Through strategic partnerships, the municipal governments have been able to access new sources of finance and support. For example, through IMECBIO and the DRBSM, institutions from Canada, the United States and Cuba provided technical advice and funding to the municipalities, which are not readily available to other municipalities in this rural region.

One particular feature demonstrates the relevance of the inter-municipal initiative among municipal governments. When the municipal elections were held in 2003, in five out of the eight municipalities that were participating in the initiative at the time, the governing political party was not re-elected. In Mexico, when the political administration changes, it is common practice for the new government to discontinue soon after taking office those projects implemented by the previous government. In this case, however, the five new mayors voluntarily continued their predecessors' commitment to formally participating in the inter-municipal initiative, which reflects the value that both they and their citizens attribute to this new river basin management institution.

Furthermore, in 2005, the Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin was recognized when it received Mexico's National Award for Local Government and Management (financed by the Centro de Investigación y Docencia Económicas [Centre for Economic Research and Education, CIDE A.C.] and the Ford Foundation), for its work around sustainable natural resources management.⁽³⁹⁾

39. <http://www.innova.gob.mx/ciudadanos/practicas/cide/>.

IV. THE "INTER-MUNICIPALITY": A NEW FORM OF GOVERNANCE FOR ENVIRONMENTAL MANAGEMENT AND DECENTRALIZATION

As in other parts of Mexico, the natural resources of the Ayuquila river basin are being rapidly degraded. This has a series of negative impacts on the local economy, by depleting the natural capital upon which rural communities depend for their livelihoods, through the reduction of the ability of ecosystems to provide environmental services such as fresh-water flow, and from the increased risk of natural disasters such as floods. Although the federal and Jalisco state governments have endeavoured to curb natural resource degradation through public policies, these have proved inadequate, leading to an increasing justification for the involvement of municipal governments in addressing environmental problems. Therefore, in Mexico, new powers and responsibilities for certain aspects of environmental management, land use planning and natural resources planning have been decentralized to the municipal government level.

However, the majority of local governments have lacked the institutional capacity to assume these new functions. This is exacerbated because the environmental problems typically faced by municipalities transcend their own administrative boundaries, as in the case of river basin management. In addition, they have limited financial resources or well-trained staff, their institutional and legal framework is weak, and the information available to them on which to base decision making is limited and incomplete. Such limitations on local governments were addressed in 1999 through further amendments to Article 115 of the Mexican Constitution, which permitted local governments to engage in the joint provision of public services for increased efficiency. These reforms open up new opportunities for municipal governments to assume a more active role in addressing environmental problems.

Based on the association of municipal governments and public participation, the inter-municipal initiative represents the start of a learning curve in the creation of new mechanisms for governance for sustainable development and the decentralization of environmental management at both the municipal and the river basin levels. The experience so far suggests that several elements of the initiative are potentially replicable in other regions and municipalities in Mexico. Indeed, visitors have come from more than 15 municipalities in Mexico, and 24 other countries, to see the initiative in practice. In 2006, five municipalities from the state of Yucatán in southeastern Mexico established a similar model of municipal cooperation, based on the visits made by their representatives to the Ayuquila river basin. The initiative also features as a case study within a distance learning course on local watershed management offered by both the United Nations university based in Tokyo, Japan, and the University of Guadalajara, and is used as a learning and discussion tool in courses given by the leadership in environment and development programme (LEAD-International) and the University of Wisconsin-Adison.⁽⁴⁰⁾

The inter-municipal initiative is an example of how municipal governments can form associations to meet complex agendas that extend beyond short political terms, within a context of rapid political change. In addition, it demonstrates how, by forming associations, local governments are better able to confront financial limitations and weak

40. See, for example Patron, Luis, Eduardo Santana Castellón, Sergio Graf Montero, Luis Martínez and Salvador García (2005), "Ayuquila River e-case study", United Nations, Tokyo, Japan, <http://www.onlinelearning.unu.edu/ayuquila/main.html>; also <http://casestudies.lead.org/index.php?cscid=151>; and http://www.ies.wisc.edu/international/landscape/case_study_ayuquila.htm.

institutional capacity to undertake environmental management. If they also form alliances with civil society groups or academic institutions, they can trigger processes that propose innovative solutions to existing problems. This type of collaborative programme, therefore, offers the advantages of economies of scale, while also increasing the operational capacity of each of the participating municipalities. Examples from the inter-municipal initiative in the Ayuquila river basin include the Inter-municipal Environmental Education Programme, the creation of an Inter-municipal Geographical Information System and other collaborative programmes for improving river water quality.

This innovative form of governance for sustainable development provides opportunities to devise public policies that integrate the national, regional and local levels of government, and produce cross-cutting responses to environmental problems. Furthermore, it helps to foster a culture of sustainability by gaining the support of citizens who are more aware and involved. In this way, it creates optimal conditions for the implementation of sustainable urban and rural activities to both reverse degradation and conserve natural capital, in order to move towards more equitable regional development.

V. CHALLENGES AND LIMITATIONS

Although the inter-municipal initiative has made important progress, it has encountered a number of conflicts and obstacles that have hindered its development. Some specific examples are as follows:

- Participation in the inter-municipal initiative is completely voluntary and is not yet subject to a set of rules and regulations. The participation of municipal governments from different political parties can produce tension, especially during election periods. So far, the initiative has successfully secured the commitment of the various mayors, which to a certain extent has shielded it from conflicts between different parties. However, full cooperation between different municipal administrations can only be maintained over the longer term if the collaborative agreement underlying the initiative is institutionalized.
- It has been clear that the various municipal governments have understood the initiative in different ways, and valued it for different reasons. Some mayors have seen the importance of the initiative as a vehicle through which to address regional problems that affect a number of municipalities, which has prompted them to prioritize the allocation of resources to activities in all of the municipalities involved. However, other mayors have striven to use the initiative as a means of attracting more investment to their own municipalities. This situation is understandable when considering that the majority of municipalities have very limited resources, and naturally they will attempt to obtain the most investment possible in order to boost their own development and thus be able to demonstrate tangible achievements to their citizens.
- The three-year political term of office held by municipal government administrations is extremely short. When a new administration takes office, the first year is usually taken up with ascertaining the situation

in the municipality and winning over the citizen base to the new government. The second year is the only period that is really used for effective action, because the third year is dedicated to the election campaign. Although the short political terms have not yet jeopardized the initiative, the mayors pay much less attention to it towards the end of their terms of office.

- The very nature of the inter-municipal initiative suggests that it should be linked to the Environment and Sustainable Development Secretariat,⁽⁴¹⁾ the government agency responsible for formulating environmental policy in Jalisco. However, the secretariat not only failed to support the initiative during its early stages, but also obstructed it from the outset. This is an example of how intermediate state-level government agencies view institutional innovations that generate local capacity as a threat to their own political power. State agencies fear that such new institutions will encroach upon or take over their functions, and thus diminish their relevance, weaken their political links with local communities and, ultimately, lead to their existence as institutions being questioned. Therefore, it is not uncommon for intermediate government agencies to oppose innovative local empowerment processes. Faced with this situation, steps were taken to incorporate another state government agency, the Jalisco State Rural Development Secretariat, as a partner into the inter-municipal initiative. The secretariat is one of the long-standing institutional collaborators in the management of the Sierra de Manantlán Biosphere Reserve, and is currently the principal contributor to the trust fund for the inter-municipal initiative. However, staff turnover at the secretariat could pose a major obstacle to consolidating its involvement in the inter-municipal initiative because new staff members might not recognize the value of the association of municipal governments and restrict the use of the agency's budget allocation.
- Each year, the Jalisco state government budget allocates an insufficient sum of money to the inter-municipal initiative, which has forced the initiative to apply directly to the state congress to increase its funding allocation. In this regard, the appeals made by a local state deputy, who was one of the founding mayors of the inter-municipal initiative, were influential in securing the necessary additional funding.
- At the federal level, the initiative received financial support from the Ministry of Environment and Natural Resources in its first year underway. However, due to new legal regulations on federal government participation in private trust funds, the initiative has not yet been able to receive finance directly from the federal government. This means that new mechanisms for federal financing need to be identified.

41. Secretaría del Medio Ambiente para el Desarrollo Sustentable (SEMADES).

VI. CONCLUSIONS

As previously mentioned in relation to local government reform, the amendments to Article 115 of the Mexican Constitution have decentralized some responsibilities from the federal and state government levels to the municipal level. In terms of the environment, the State Ecology and

Environmental Protection Law⁽⁴²⁾ strengthens local autonomy by giving municipal governments influence over various aspects of natural resources regulation, pollution control and land management. Environmental management is now one of the municipal responsibilities that covers important issues related to water supply and wastewater treatment, solid waste management and spatial planning, including the control of land use change. The municipality, therefore, plays an important role in the implementation of public policies for the conservation and sustainable use of water, which is a strategic resource for development in Mexico.

The inter-municipal initiative thus represents important progress in developing decentralized and democratic local management in Mexico. However, the following aspects also need to be developed for the adequate and successful execution of municipal responsibilities:

- securing the necessary technical and management capacity at the municipal level, in order to design and implement programmes for social development, environmental management and public service provision;
- ensuring democratic and effective citizen participation in decision-making processes, in order to share responsibility in the implementation of public policies;
- instilling the principles of public service into government authorities; and
- increasing the deconcentration of financial resources to the local level, and thus their capture by municipal governments.

In Mexico, individual rural municipalities with populations of less than 50,000 inhabitants have difficulty in developing the above objectives on their own, primarily due to their lack of financial resources and technical capacity. The principal challenge that lies ahead for the inter-municipal initiative is to achieve institutional consolidation through the creation of a specific Inter-municipal Environment Agency, which would provide technical services to the municipalities and help them to strengthen their autonomy in the face of changes arising from the six-year political terms at the federal and state government levels. A further goal is to establish a professional career civil service, whereby government staff would remain in post through successive political administrations, which would give continuity to public policies for environmental and natural resources management in each municipality and within the wider region.

The inter-municipal initiative presents a new opportunity if, in addition, it is able to establish links between the strategic association of municipalities and other government authorities, academic institutions and civil society organizations, in order to obtain the necessary public, political, financial and informational support to implement its plans and fulfil its development objectives. Together with the consolidation of channels for citizen participation in the definition and design of public policies, as well as in the monitoring of their implementation, the combination of these elements is essential for achieving good governance towards sustainable development.

REFERENCES

- CAP-NET (2005), "Integrated water resources management plans: training manual and operational guide", Capacity Building for Integrated Water Resources Management (CAP-NET), Delft, the Netherlands.
<http://casestudies.lead.org/index.php?cscid=151>
- CNA, (2001), "Estudio de disponibilidad y balance hidráulico actualizado de aguas superficiales de la Región Hidrológica Río Armería", Comisión Nacional del Agua, Mexico.
- CNA (2003), *Estadísticas del Agua en México*, Comisión Nacional del Agua, Mexico.
- CNA, (2005), *Estadísticas del Agua en México*, Comisión Nacional del Agua, Mexico.
- Dourojeanni, Axel (2000), "Water resources and river basin management in Latin America", United Nations Economic Commission for Latin America and the Caribbean (ECLAC), Santiago, Chile.
- García Ruvalcaba, Salvador (2002), "Reciclaje y saneamiento del río Ayuquila en la Reserva de la Biosfera Sierra de Manantlán", *Revista DaVinci* Vol 4, No 99, pages 23–41.
- Graf Montero, Sergio and Jesus Rosales Adame (1995), "Diagnóstico sociodemográfico de la Sierra de Manantlán y su región de influencia", unpublished technical report, Secretaría de Medio Ambiente, Recursos Naturales y Pesca and the *Instituto Manantlán de Ecología y Conservación de la Biodiversidad*, University of Guadalajara, Mexico.
- Graf Montero, Sergio, Cesar Aguilar and Salvador García Ruvalcaba (1996), "The conservation and development of the Ayuquila River in the Sierra de Manantlán Biosphere Reserve", modified version of a paper presented at the ACSP–AESOP Joint International Congress "Local Planning in a Global Environment" (translated by Daniel Schneider, edited by Eduardo Santana Castellón), Toronto, Canada, 25–28 July.
- Graf Montero, Sergio, Eduardo Santana Castellón, Enrique Jardel Pelaéz, Martín Gómez and Salvador García Ruvalcaba (2003), "Vinculación social y arreglos institucionales para la gestión de las áreas naturales protegidas: el caso de la Reserva de la Biosfera Sierra de Manantlán, México", in J Carabias, J de la Maza and R Cadena (editors), *Capacidades Necesarias para el Manejo de Áreas Protegidas en América Latina*, Nature Conservancy, Mexico.
- GWP (2000), "Integrated water resources management", Background Paper No 4, Global Water Partnership (GWP) Technical Committee, Stockholm, Sweden.
- GWP (2004), *Catalyzing Change: A Handbook for Developing Integrated Water Resources Management (IWRM) and Water Efficiency Strategies*, Global Water Partnership (GWP) Technical Committee, Stockholm, Sweden.
- Henne, Lisa J, Daniel W Schneider and Luis Manuel Martínez Rivera (2002), "Rapid assessment of organic pollution in a west-central Mexican river using a family-level biotic index", *Journal of Environmental Planning and Management* Vol 45, No 5, pages 613–632.
- IADB (1998), "Integrated water resources management in Latin America and the Caribbean", Technical Study, Inter-American Development Bank (IADB), Washington DC.
http://www.ies.wisc.edu/international/landscape/case_study_ayuquila.htm.
- Lyons, John, Sonia Navarro Pérez, Philip A Cochran, Eduardo Santana Castellón and Manuel Guzmán Arroyo (1995), "Index of biotic integrity based on fish assemblages for the conservation of streams and rivers in west-central México", *Conservation Biology* Vol 9, No 3, pages 569–584.
- Martínez Rivera, Luis Manuel, Eduardo Santana Castellón and Arturo Carranza Montaña (1998), "Informe sobre la derrama de melaza ocasionado por el Ingenio Melchor Ocampo el día 20 de marzo de 1998 y los resultados de los estudios y acciones complementarias", *Instituto Manantlán de Ecología y Conservación de la Biodiversidad*, University of Guadalajara, Mexico, 28 March.
- Martínez Rivera, Luis Manuel, Arturo Carranza Montaña, Angel Aguirre García, Georgina González, John Lyons, Daniel W Schneider and Lisa J Henne (1999), "Evaluación del impacto del siniestro ocurrido por la descarga de melaza del Ingenio Melchor Ocampo sobre el río Ayuquila, Reserva de la Biosfera Sierra de Manantlán", *Instituto Manantlán de Ecología y Conservación de la Biodiversidad*, University of Guadalajara, Mexico.
- Martínez Rivera, Luis Manuel, Arturo Carranza and Micaela García (2000a), "Aquatic ecosystem pollution of the Ayuquila River, Sierra de Manantlán Biosphere Reserve, Mexico", in M Munawar, S G Lawrence, I F Munawar and D F Malley (editors), *Aquatic Ecosystems of Mexico: Status and Scope*, Ecovision World Monograph Series, Backhuys, Leiden, The Netherlands, pages 165–181.
- Martínez Rivera, Luis Manuel, Eduardo Santana Castellón, Luis Ignacio Iñiguez Dávalos and J Francisco Santana Michel (2000b), "Programa de acciones del Ingenio Melchor Ocampo para la restauración del río Ayuquila", *Instituto Manantlán de Ecología y Conservación de la Biodiversidad*, University of Guadalajara, Mexico.
- Martínez Rivera, Luis Manuel, Eduardo Santana Castellón and Sergio Graf Montero (2002), "Una visión del manejo integrado de cuencas", Integrated Ecosystem Management Course, Colegio de Postgraduados, Mexico, 25 February–1 March.
- Moreno, Carlos (2004), "Fiscal performance of local

- governments in Mexico under decentralization: a political explanation”, Paper presented at the Meeting of the Latin American Studies Association, Las Vegas, United States, 7–9 October.
- Moreno, Luis Alberto (2006), “Implementation of integrated water resources management”, Paper presented at the 4th World Water Forum, Mexico City, 16–20 March.
- Patron, L, E Santana Castellón, Sergio Graf, Luis Martínez and Salvador García (2005), “Ayuquila River e-case study”, United Nations, Tokyo, Japan, <http://www.onlinelearning.unu.edu/ayuquila/main.html>.
- Rees, Judith (2005), “IWRM, water efficiency plans and urban water services”, unpublished paper for the Technical Advisory Committee, Global Water Partnership (GWP), Stockholm, Sweden.
- Sánchez Bernal, Antonio (2002), “Las posibilidades del desarrollo económico local en México”, Report based on a paper presented at the conference “Gobiernos Locales: El Futuro Político de México”, *Instituto Tecnológico de Estudios Superiores de Occidente*, Guadalajara, Mexico, 23–24 September 1999.
- Sandoval, Juan Martín (2000), “Compendio sobre el agua: un análisis temático para la introducción al que hacer legislativo”, Comisión de Asuntos Hidráulicos de la Cámara de Diputados, Mexico.
- Santana Castellón, Eduardo, Sonia Navarro Pérez, Luis Manuel Martínez Rivera, Angel Aguirre, Pedro Figueroa and Cesar Aguilar (1991), “Contaminación, aprovechamiento y conservación de los recursos acuáticos del río Ayuquila, Reserva de la Biosfera Sierra de Manantlán, Jalisco–Colima”, in *Tiempos de Ciencia* Vol 30, pages 29–38.
- Santana Castellón, Eduardo and Sergio Graf Montero (2001), “Iniciativa local para el manejo integral de la cuenca del río Ayuquila: contribución al Programa de Desarrollo Regional Sustentable (PRODERS) región Sierra de Manantlán”, unpublished report, *Instituto Manantlán de Ecología y Conservación de la Biodiversidad*, University of Guadalajara, Mexico.
- United Nations Habitat (2003), “Improving urban water and sanitation provision as part of integrated water resources management”, in *Water and Sanitation in the World's Cities: Local Action for Global Goals*, Earthscan, London, pages 193–223.
- United Nations Habitat (2006, in press), “Integrated water resources management and the provision of water supply and sanitation to small urban centres”, in *Water and Sanitation in the World's Cities 2006: Meeting Development Goals in Small Urban Centres*, Earthscan, London.