PANAMA – THE MANAGEMENT OF THE PANAMA CANAL WATERSHED (PCW), CASE #5

This case study is about the Panama Canal Watershed, its development in legal, technical and social terms, the problems encountered, and how an Integrated Water Resources Management approach could help it to be managed in a more sustainable way.

ABSTRACT

Description

The Panama Canal Watershed (PCW) was developed when the Panama Canal was constructed (1904-1914). The PCW unites the basins of the Chagres and Grande Rivers into a single hydraulic system. The Chagres and Grande Rivers drain into the Atlantic and the Pacific Oceans, respectively. Damming the Chagres River provides water to operate the canal locks. By the mid 1930's, an additional lake had been created in the upper basin of the Chagres River to increase the water storage capacity of the system. In 1999, the formal limits of the PCW were established by law and segments of the Indio, Caño Sucio and Coclé del Norte River Basins were added. All these rivers drain separately into the Atlantic Ocean to the north-west of the PCW.

Under the Panama Canal Treaty (1977) the Republic of Panama was obliged to provide sufficient water for the operation of the Canal and for cities in the area. This led to the creation of several national parks, the promotion of sustainable development activities, and the implementation of base-line studies, all with support from USAID (United States Agency for International Development). A Panama Canal Authority (PCA) was created by Constitutional reform in 1994 which granted legal obligations and rights to manage the PCW. A land use plan and an Organic Law for the PCA were approved in 1997, though the former has yet to be implemented.

Lessons learned

- The IWRM concept could be useful for the management of the PCW;
- IWRM has many prerequisites, including an adequate legal framework and effective structures for water management, scientific knowledge and knowledge dissemination;
- Traditional centralised approaches to government and the lack of public participation severely hinder the practical implementation of IWRM;
- A hydraulic or watershed culture is needed for the creation and development of adequate terms of understanding between all parties involved in IWRM;
- It is vital to recognise that there may be legitimate conflicts between stakeholders; this recognition encourages collaboration between all parties involved in IWRM;
- IWRM should be seen as a component of a broader sustainable development strategy.

Importance for IWRM

This case study illustrates the peculiar problems which arise when a highly artificial watershed is managed by a modern, internationally-oriented public corporation in an underdeveloped country which lacks a hydraulic culture (Wittfogel, 1956) and a national water policy. The study demonstrates the relevance of the IWRM concept as a tool for better understanding of the undergoing management process in the PCW, although the PCW is at a very early stage in its development. It also illustrates the importance of an IWRM approach for the future of sustainable development in Panama, including the sustainability of the services provided by the country for world commerce.

Main tools used

A2.3 Reform of existing legislation
B2.1 Participatory capacity and empowerment in civil society
C2.2 Basin management plans
B1.9 Civil society institutions and community based organisations

MAIN TEXT

1 Background and problems

Area and scale

The PCW covers 5,527.6 km², equivalent to 6.5% of the country's territory (see figure 1 for a map of the Canal Zone). This includes two main components – the "traditional" watershed and the "western" watershed. The physical watershed of the Panama Canal is commonly known as the "traditional" watershed and covers 3,396.5 km². This includes the combined basins of the north-bound Chagres River and the south-bound Grande River. They form a single system at the Gaillard Cut, which lies across the central highlands of the Isthmus and was constructed between 1904 and 1914. This system includes the Gatún Lake, created in 1914, and the Alajuela Lake, created as an additional reservoir in the upper Chagres River Basin with the construction of the Maden Dam (completed by the mid 1930's). The second component is the "western" watershed, covering 2,131.1 km² to the north-west. This includes the watersheds of the north-bound Coclé del Norte, Indio and Caño Sucio Rivers, which all drain into the Atlantic Ocean. The two components form a single management unit, known as the Canal Hydrographic Watershed (figure 2), where the "western" watershed serves as a protection belt and a potential water reserve for the "traditional" watershed.

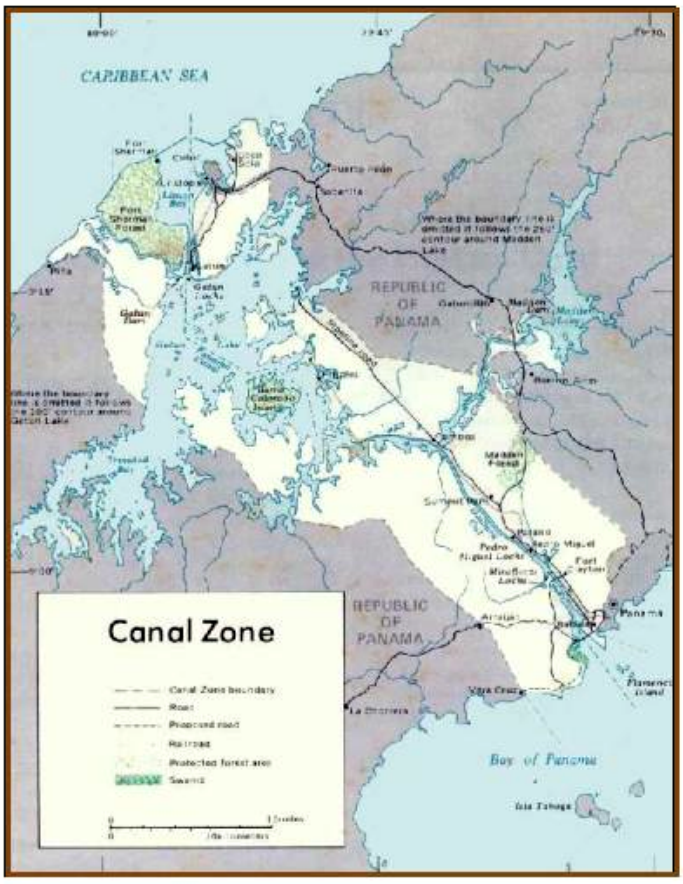

Figure 1: The Canal Zone, Panama 1914-1979

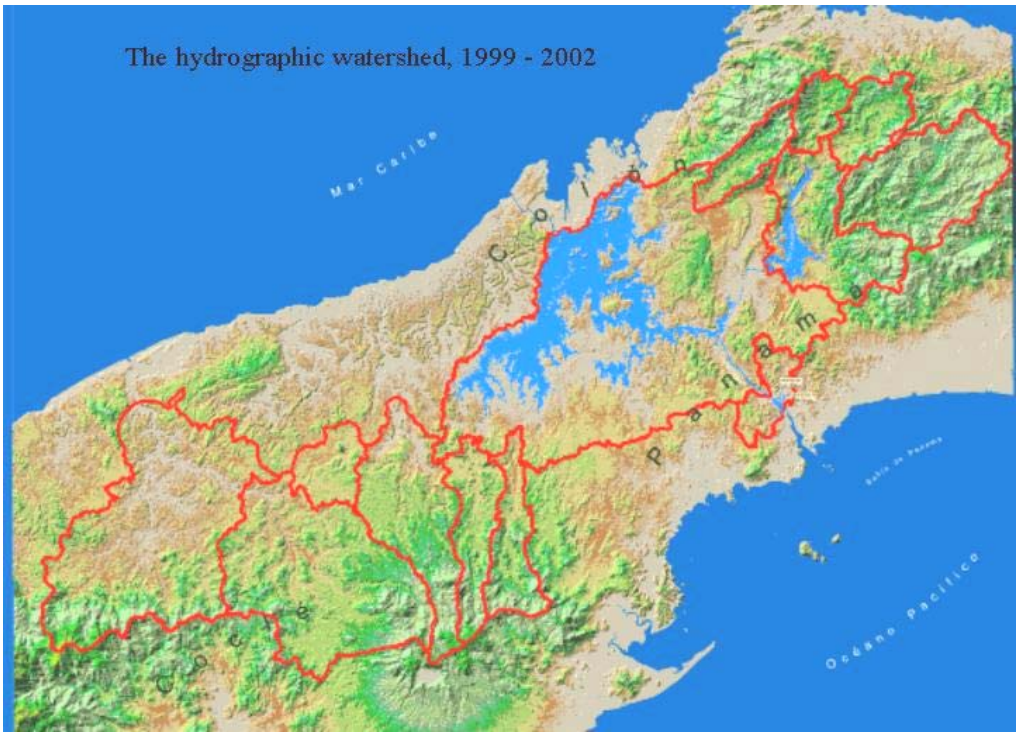

Figure 2: The hydrographic watershed of the Panama Canal 1999-2002

Population, economy and public administration

The population of the PCW increased from 21,000 people in 1950 to 188,000 in 2000. 60% of this population lives in rural settlements, and the remaining 40% in settlements with 1500 inhabitants or more. 21% of the total population lives in the "western" watershed, and 79% in the "traditional" watershed. 62% of the total population resides along the Trans Isthmian Highway, built in the late 1940's to link the cities of Panama and Colón, which lie at the southern and northern ends of the waterway, respectively. One single community on the highway, Chilibre, contains 50% of the total population of the PCW. Approximately 60% of the total population lives in poverty, of both a rural and urban nature.

The political and administrative structure of the PCW includes parts of 3 provinces (Panama, Colon and Cocle), 11 Districts and 48 Corregimientos (a sub-District administrative unit of great importance for local development). All the Provinces and Districts, as well as the corregimientos, include lands and population outside the PCW. All the Ministries and other relevant organisations of Central Government have District-level branches which have very different, and sometimes competing, responsibilities in different segments of the PCW.

The most important forms of land use in the PCW include extensive cattle raising (39%), Canal operations (34%), protected areas and National Parks (20%), and urban development (6%), including some industrial and agro-industrial activities along the Trans Isthmian Highway. Agriculture and forestry use less than 2% of the land. There are important differences in the social and economic structures of the two segments of the PCW. The "western" watershed is more rural, whereas the "traditional" watershed includes important urban components and is more strongly linked to the country's economy. However, the PCW as a whole can be described as a predominantly rural enclave, surrounded in the south, the south-west and the north by urban areas under expansion. These urban areas are suffering the worst consequences of unsustainable rural and urban development.

Water use in the Panama Canal Watershed

The PCW serves local and international demands. It produces some 5,000 million m^3 of water per year, of which some 500 million m^3 are discharged into the ocean to prevent flooding of the Canal locks. Canal operations use 94% of the remaining water – 60% for lock operations and

34% for hydroelectric generation – to provide inter-oceanic transit services for 4% of the world's maritime traffic. The remaining 6% is used by the National Institute for Water and Sewage Services (IDAAN, sp.) to provide potable water for more than half the country's population, and more than two-thirds of industrial and service sector needs.

These facts highlight the peculiar economic structure of the country, where the service sector provides about 70% of the Gross Domestic Product, the industrial sector provides about 15%, and the agricultural sector some 10%. Service and industrial activities are concentrated in the urban areas near the Canal. This means that the PCW supports, both directly and indirectly, some 80% of the country's GDP, and more than half its population.

Political background of the Panama Canal Watershed

Until the negotiation of the Panama Canal Treaties, between 1970 and 1977, the Canal operated as a US Government public facility within a zone that covered some 1280 km², stretching 8 km on either side of the Canal. The US were granted the right to behave "as if they were sovereign" in this zone by the 1903 Hay-Buneau Varilla Treaty. The zone was located in the "traditional" PCW, but was economically, politically and socially isolated from the Republic of Panama as well as from its natural surroundings. The Republic of Panama, on its part, lacked any relevant experience in watershed management, even after the development of a dam construction programme that, by the late 1970's, provided about 70% of the country's electricity demand.

Problems facing the PCW

Three factors have been identified which could affect the quality, availability and sustainability of the water supply to the Panama Canal and surrounding cities (Vargas, Carlos: personal communication):

- **Erosion – sedimentation**
  Although it is not considered an immediately relevant problem, the Panama Canal Authority (PCA) has a programme to prevent sedimentation. This includes monitoring suspended sediments in the most important rivers of the PCW and reforesting lands at risk, educating the population of the watershed about the environment and co-ordinating other activities with different governmental organisations. Detailed studies have only been made in Alajuela Lake, due to the acute inclination of the slopes in its watershed and its high productivity of water. The PCA estimates a loss of 17% in its storage capacity between 1935 and 1998 as a result of sedimentation (a loss of 5% per year is considered reasonable). Other activities include dredging Gatún Lake in order to increase its storage capacity and diminish the need for discharges.
- **Quality of water**
  The PCW provides water to four treatment plants: Chilibre, at Lake Alajuela, and Miraflores, Laguna Alta, Escobal and Monte Esperanza, at Gatún Lake. The base-line studies conducted in the PCW by the National Environmental Authority (ANAM, sp.) and the Smithsonian Tropical Research Institute (STRI) in the late 1990's concluded that there is serious pollution in the mid course of the Chagres River, especially in the area of Chilibre. This pollution is mostly due to urban development and agro-industrial activities (Heckadon *et al*., 1999). The same situation is evident all along the Trans Isthmian Highway. As a legal requirement, the PCA has started monitoring and analysing water quality in the PCW, but has not yet published a report on this issue.
- **Quantity of water and increased demand for water**
  Internal and external studies conducted by the PCA have demonstrated that there will not be a significant long-term reduction in precipitation in the PCW. Even so, periodical fluctuations in water provision associated with El Niño events, and an increasing demand for water for Canal operations and human uses needs to be allowed for, especially through the improvement of storage capacities and the prevention of erosion and sedimentation processes.

Legal framework of the PCW

Article VII-3 of the Panama Canal Treaty mandates the Republic of Panama to "take the necessary measures to ensure that any other land or water use within the Canal's watershed will not deplete the water supply necessary for the continuous efficient management, operation or maintenance of the Canal". After the Treaty began to be implemented in 1979, discussions about the PCW management were held (mostly in relation to deforestation and the impact of rural colonisation and peasant agriculture). Some initiatives were taken, like the creation of national parks in the PCW, and the organisation of the NATURA Foundation in 1992, funded mostly by USAID, to provide financial support for reforestation and conservation in the PCW. The parks, particularly the Chagres National Park, have provided an important contribution to the protection of the PCW. The NATURA Foundation continues to provide funding for several small-scale forestry and agro-forestry projects.

Although the goal highlighted in Article VII-3 and the measures to be taken in order to achieve it were defined in the 1980's, no significant action for the integrated management of the PCW was taken until 1994, five years before Panama had to become fully responsible for the Canal. In 1994, the Panama Canal Authority (PCA) was created following reform of the nation's Constitution. This made the PCA responsible for the administration, maintenance, use and conservation of the water resources of the PCW. From 1997 onwards, a whole legal framework began to be created, including as its main components the following:

- The creation of the PCA's Organic Law (19/1997). This makes the PCA responsible for managing the water resources required to operate the canal and for supplying the surrounding populations with sufficient water;
  - The adoption, under Law 21/1997, of a land use plan for the PCW (the Law has yet to be implemented). This plan aims to guarantee the availability of water by reducing sedimentation, e.g. by reducing pastures from 39% to just 2% of the PCW's lands, while increasing the area under forestry and agroforestry from 0.5% to 23%. This process will include compensation to landowners;
- Between 1996 and 1999, a project was undertaken to monitor the environmental situation in and problems of the "traditional" watershed; this was carried out by the STRI for the ANAM, with financial support from USAID;
- The creation, under the PCA's Resolution 16/1999, of an *Inter-institutional Commission for the Hydrographic Watershed* (ICHW). This is dependent on the PCA's General Administrator Office, and is supported by the Ministries of Government, Agricultural Development and Housing; the ANAM and the Inter-oceanic Region Authority, as well as the NATURA Foundation and a Catholic church social promotion agency (as representatives of civil society). The ICHW's structure includes a Technical Permanent Committee, which, besides the Commission's members, includes technical representatives from the Ministries of Commerce, Education, Health and Public Works, the IDAAN, and the Social Investment Fund of the Presidency of the Republic, as well as one observer from the Municipal Government of Panama City;
- The definition of the PCW's limits and area under Law 44/1999, which added the "western" watershed to the "traditional" one.

The legal framework – problems and outcomes

No alternatives to the above-mentioned measures were considered. In addition to this, the process was conducted by the Government and the PCA in a highly technocratic style, with public consultation mostly restricted to the country's socio-economic and political élite, and to formal parliamentary procedures. The measures adopted led to a vast process of reorganisation within the PCA, aimed at transforming the Canal Authority into an efficient, profit-oriented Public Corporation. In general terms, this reorganisation seems to have been quite successful at a technical and commercial level. It included the creation of an International Advisory Board, with high-level representatives from the most important clients of the Canal and public corporate personalities. However, it seemed easier for the PCA to relate to global partners than to its own national society. The first sign of difficulties at a local level appeared in December 1999, when the Catholic Bishop of Colón, Msgr. Carlos María Ariz, sent a letter to the President of the Republic, telling her about the rejection of Law 44/1999 by peasants and missionaries of

the Diocese, due MOSTLY TO THE FACT THAT the people of the new "western" watershed had not been consulted about the law; it was not a matter of public discussion in the media, and was approved with little debate by the National Assembly.

The Bishop asked the President to take "opportune decisions" to ensure the protection of peasants against the risks of modernisation, and to make sure that future development would provide "deep satisfaction and permanent social well-being for all".

Following this, the management of the PCW ceased to be perceived as a mostly technical, engineering problem, and started to be considered as a social and political one as well. The PCA started to build new capacities so that it would be able to work with the people – and not just with the Government – of the country which now owns the Canal. This, in turn, also created, for the first time in the history of the Republic, the possibility to start an IWRM process associated with the country's most important watershed.

2 Decisions and actions taken

Key implementation issues

As previously stated, the management of the PCW started in 2000, and is at a very early stage in its implementation. Selecting ways to define and implement a plan and creating and strengthening the co-ordination mechanisms for all the parties involved in the Inter-institutional Commission for the Hydrographic Watershed (ICHW) are probably the most important problems being faced by the PCA at this time. This includes initiatives and activities such as:

- Defining a basic strategy for guaranteeing the availability of water by reducing sedimentation (as mentioned previously, this is implicit in Law 19/97);
- Implementing the first base-line study of the "traditional" watershed by the ANAM and the STRI (Heckadon *et al*., 1999);
- Implementing a "base-line" study – bio-geophysical, socio-economic and cultural – of the "western" watershed by a consortium created by the STRI, the University of Panamá and Louis Berger Inc., a private consulting firm;
- Organising the ICHW, including the definition of co-ordination procedures for collaboration between the PCA and other Government agencies, as well as procedures and a programme for other Commission activities;
- Starting a programme on educating the public about the PCW.

Two key implementation issues have emerged. Firstly, existing Government structures are highly centralised and specialised, and are difficult to co-ordinate in any new type of joint partnership. Secondly, both the social organisation and environmental culture in Panama are extremely weak; this has deprived the process of truly representative, politically effective non-Government counterparts.

Regarding the first of these issues, most attention was devoted to the creation of a mechanism adequate to fulfil the PCA's responsibilities towards the PCW in co-ordination with other Government and some Non-government actors, and to the creation of new capacities for the management of environmental issues within the PCA. Capacity building included the creation of the ICHW in late 1999, as mentioned, and the Department of Security and the Environment, whose aim is to offer technical support to the management process. The Department of Security and the Environment includes an Environmental Management Division and a Watershed Management Section, all formalised between January and March 2002. The new structure includes a specialised unit for monitoring the PCW, and studies of the "western" watershed are under way. Besides this, the PCA has obtained advisory and training services from US agencies and consulting firms with experience in watershed management.

Although there have been no changes at the ICHW level, new initiatives are under way at the "western" watershed to start working with peasants' communities, mostly in land entitlement. Resistance to Law 44/1999 by peasants' organisations and Church organisations at grass-roots level has stimulated more interest and debate in the PCW's management issues than had been

anticipated. At the same time, other actors, who had not been considered to be part of the management process, began to demand participation in it, including the cattle ranchers in the "traditional" watershed.

This has led to some unexpected, beneficial outcomes. Both the National and the Catholic Universities of Panama, for instance, have initiated graduate studies programmes related to the integrated management of the PCW. At the same time, there has been discussion in the media and in other social and environmental related NGOs of differences between the PCA and other actors. This discussion relates to the PCW's legal delimitation and management criteria, as well as public education initiatives on the part of PCA and has made a very important contribution to the development of public awareness on the issue of water management in Panama.

3 Outcomes

It is too early to offer an evaluation of achievements and performance regarding the PCW management process in an IWRM perspective. Positive outcomes to date include:

- The creation of a legal framework;
- The ICHW has been organised and is working;
- The identification of some key issues;
- The PCA is supplying most of the resources (human, technical, financial) needed for the work under way;
- The other ministries and institutions participating in the ICHW are also providing technical personnel and support.

However, it has not been possible to implement the 1997 Land Use Plan, which is already being questioned by cattle ranchers. Important stakeholders of the PCW – e.g. business and agribusiness interests, real estate developers and middle-class and poor urban dwellers – have not yet been incorporated into the existing consulting mechanism. Social participation is therefore limited to poor peasants – represented by a Church agency – and conservationists. Differences between the PCA and other Government agencies persist, and the country still lacks a national water policy that could provide a common framework for all parties involved.

A contributing factor to these delays could be the increasing political instability in Panama after the death of General Omar Torrijos in July 1981, which led to the Noriega regime and the US military invasion of December 1989. The creation of the basic legal framework for the organisation of the Canal and the PCW management under Panamanian responsibility happened after US withdrawal, under the Administration of Presidents Guillermo Endara (1989 – 1994) and Ernesto Pérez Balladares (1994 – 1999). This occurred in close parallel with the reconstruction of Panama's civil society, as well as with the structural adjustment and State reform processes, which included the privatisation of most of the economy's public sector, and the creation of new types of institutions such as the Panama Canal Authority.

However, it is at a different level that the most important achievements are being made, including:

- A new kind of environmental culture, centred on the issue of sustainable development and associated with the practical problems posed by the PCW management, is taking shape in Panama;
- There is an increasing awareness about the fact that the social and environmental problems of the PCW are those of the entire country;
- There is also an increasing awareness that the integrated management of the country's most important watershed will soon require new kinds of environmental and development policies for the country as a whole.

Although the watershed management plan is still in its early stages, the PCA has demonstrated its willingness and capacity to adapt and evolve in the face of new challenges. There will be greater changes and more complex demands in the future, particularly regarding the issues of

co-ordination with other Government agencies, and social participation in the management process.

Important differences persist among all parties involved in long-term planning and co-ordination in IWRM. Sustainability as a practical goal, for example, is at a very elementary level of debate, still posed in abstract and bureaucratic terms rather than in practical terms, and lacking a conceptual frame for the evaluation of results. It is still too early to discuss the "winners and losers" issue as a consequence of the PCW management. Some important stakeholders are still being identified as they demand recognition and involvement, as happened with the "western" watershed peasants, while others – such as the urban dwellers of the "traditional" watershed – have not even begun to demand such recognition.

4 Lessons learned

In general terms, the case study provided the following lessons:

- The IWRM concept could be useful for the management of the PCW;
- IWRM has many prerequisites, including an adequate legal framework and effective structures for water management, scientific knowledge and knowledge dissemination;
- Traditional centralised approaches to government and lack of public participation severely hinder the practical implementation of IWRM;
- A hydraulic or watershed culture is needed for the creation and development of adequate terms of understanding between all parties involved in IWRM;
- It is vital to recognise that there may be legitimate conflicts between stakeholders; this recognition encourages collaboration between all parties involved in IWRM;
- IWRM should be seen as a component of a broader sustainable development strategy.

These lessons are related to two different aspects of IWRM:

- The necessity and possibility of developing actual PCW management as an IWRM process;
- The usefulness of PCW management experiences for IWRM itself.

At the first level (the legal, technical and political level), the PCW management experience teaches us about:

- The importance of a clear compromise on the part of Government authorities;
- The creation of an adequate legal framework;
- The improvement of scientific knowledge about the watershed to be managed;
- The dissemination to the general public of information about the watershed and its importance for the country;
- The creation of basic structures for the specific purpose of water management as a starting point for IWRM.

Some aspects of Panama's political culture are only operating at the first, concrete level. These include:

- An excessive reliance on a traditional, highly centralised approach to Government;
- A very limited public consultation and consensus building experience and capacities for the creation and use of key legal instruments;
- Limited participation of national academic and research institutions, and little public debate, combined with an authoritative, "vertical" dominant trend to approaching environmental / water education.

These factors could explain the enormous amounts of time and energy devoted to issues of command and control; a tendency to have a fragmented approach to the problems involved in the management process, and the aspiration to control public participation and debate. The most important difficulty is related to the very different social nature, interests and water-related experiences of the parties involved. The PCA, while having a water administration culture, lacked a watershed management one, having been excluded from PCW matters during the 1904-1979 "Canal Zone" years. Its position as a virtual monopolistic user of the watershed's

water, for instance, could explain the absence of a clear definition between a supply or a demand approach for the PCW management. This probably contributed to the limited participation or the absence of some key users in the initial stages of the management process, and to the persisting difficulty of defining management's strategies clearly.

At the second, more general and abstract level mentioned in the previous section (involving social and environmental aspects), there seem to be two main lessons to be learned from the PCW experience. The first one is related to the extreme complexity of the "integrated" approach in water resources management. Usually understood as essentially a technical matter, **it is instead a cultural one, deeply imbedded in the possibilities and difficulties derived from each society's history of relations with the natural world**. This is also related to the history of the roles of natural and human resources and to management at an international scale.

The possibilities of conceiving and implementing an integrated management process depend on the known problems, on one hand, and the scarcely known interactions between the many different natural resources and ways of using the land, on the other hand. In other terms, these possibilities depend on the development of a resources management system based on a new kind of knowledge management, capable of a much more integrated development of all its components. In this approach, these possibilities are virtually infinite, and provide the basic link between the two lessons to be learned from this case study.

The second level is related to the importance of context in IWRM. In itself, **IWRM is an important component of the more ample, more ambitious goal of sustainable development at the global scale**. In the long run, integrated management of water resources will only be possible in the context of sustainable development, able to address the local, national, regional and global levels of the problem. Transnational shipping corporations making use of the PCW water resources, for instance, must be committed to contributing to the sustainable use of those resources by sharing the cost of the preservation of the environmental services that made them available. As the PCW experience suggests, "think globally, act locally" through strategic partnerships of a new kind between partners. Partners may be as diverse as a small farming community in Gatún Lake, the Panama Canal Authority in Panama City, and a London or Hong Kong based shipping corporation. Partnerships will therefore be an increasingly fundamental challenge for IWRM in the years to come.

5 References

Ashton, Mark, and O'Hara, Jennifer, 1999: "Panama Canal Watershed: A Synthesis", in Ashton, Mark; O'Hara, Jennifer, and Hauff, Robert (editors), 1999: *Protecting Watershed Areas: Case of the Panama Canal*. Food Products Press, Binghamton, NY.

Asociación Mundial para el Agua (GWP), Comité del Consejo Técnico (TAC), 2000: *Manejo Integrado de Recursos Hídricos*. TAC Background Papers, No. 4, Suecia.

Atencio T., 1992: "Impact of Municipal Water Demands on Canal Water Availability", Comisión del Canal de Panamá, 62 páginas.

Ariz, Carlos María: "Carta abierta a la Excma. Señora Mireya Moscoso, Presidenta de la República, del Obispo de Colón y Kuna Yala". *Panorama Católico*, 12 de diciembre de 1999, p. 3. Panamá.

Autoridad del Canal de Panamá. Comisión Interinstitucional de la Cuenca Hidrográfica del Canal de Panamá / CICH, 2001: *Estrategia de Conservación y Desarrollo de la Cuenca Hidrográfica del Canal de Panamá (Borrador del Concepto).* Borrador de consulta. 3 de octubre de 2001.

"Carta de Monseñor", *La Prensa*, 030100, Panamá; *Canal de Panamá Hoy*, Año 9, No. 43, julio 2000. Boletín trimestral del CELA "Justo Arosemena", Panamá.

Castro, Guillermo, 2001: "On cattle and ships. Culture, history and sustainable development in Panama". *Environment & History*,7, pp. 201, 217, Cambridge, UK.

Dourojeanny, Axel, 1994: "La gestión del agua y las cuencas en América Latina". *Revista de la CEPAL*, 53, agosto 1994.

Heckadon, Stanley; Ibáñez, Roberto y Condit, Richard (editors), 1999: *La Cuenca del Canal: deforestación, urbanización y contaminación. Proyecto de Monitoreo de la Cuenca del Canal (PMCC). Sumario Ejecutivo del Informe Final*. Smithsonian Tropical Research

Institute, USAID, Autoridad Nacional del Ambiente. Instituto Smithsonian de Investigaciones Tropicales, Panamá.
Lowenberg, Maya, 1999: "Sedimentation in the Panama Canal Watershed", in Ashton, Mark; O'Hara, Jennifer, and Hauff, Robert (editors), 1999: *Protecting Watershed Areas: Case of the Panama Canal*. Food Products Press, Binghamton, NY.
Ministerio de Desarrollo Agropecuario, República de Panamá, 2001: *Programa de Manejo Sostenible de las Áreas Rurales de la Cuenca Hidrográfica del Canal de Panamá (MASAR – CHCP). Documento Nacional de estrategia y Concepto para la Formulación de un Programa de Inversiones*. Borrador para discusión. Panamá, julio de 2001.
O'Hara, Jennifer L., 1999: "Introduction: The Panama Canal Watershed Area", in Ashton, Mark; O'Hara, Jennifer, and Hauff, Robert (editors), 1999: *Protecting Watershed Areas: Case of the Panama Canal*. Food Products Press, Binghamton, NY.
Panama Canal Authority, 2001: www.pancanal.com/eng/mapa.html Legal Foundation: "Organic Law"; "Constitutional Title". Regulations: "Regulation on the Environment, Watershed, and Interinstitutional Comission on the Canal Watershed" (Spanish); "Regulation on Organization and Definition of Responsibilities of the Panama Canal Authority" (Spanish).
Van Hofwegen, Paul J.M., Jaspers, Frank G.W., 2000: *Marco Analítico para el Manejo Integrado de Recursos Hídricos. Lineamientos para la evaluación de marcos institucionales*. Estudio comisionado por la División de Medio Ambiente del Banco Interamericano de Desarrollo, Washington, D.C.
Vargas, C.A., 1999: "The Extended Report on the Results of the Third Inter – American Dialogue on Water Management. Applied to the Panama Canal Watershed". Donoso, María C., y Cornejo R. de Grajales, María P. (editors): *Integrated Water Resources Management in the Americas. Multi-disciplinary approach and recommendations from the Third Inter – American Dialogue on Water Management*. Inter – American Development Bank, CATHALAC, Panamá.
Vargas, C.A., 1996 : *"La Administración de los Recursos Hídricos: Pieza Fundamental para el Funcionamiento del Canal",* Documento Presentado al Comité de Cuenca y Medio Ambiente de la Comisión de Transición para la Transferencia del Canal de Panamá, Comisión del Canal de Panamá, Balboa, 21 de Mayo de 1996.
Whitney, Sarah N., 1999: "Will the Goals be Met? An Examination of ARI's General and Regional Plans with Respecto to Protected Areas Within the Intr – Oceanic Region, Panama", in Ashton, Mark; O'Hara, Jennifer, and Hauff, Robert (editors), 1999: *Protecting Watershed Areas: Case of the Panama Canal*. Food Products Press, Binghamton, NY.
Wittfogel, Karl A., 1956: "The hydraulic civilizations", in *Man's Role in Changing the Face of the Earth*. The University of Chicago Press.
Worster, Donald, 1992: *Rivers of Empire. Water, Aridity and the Growth of the American West.* Oxford University Press, New York Oxford.

6 Contacts

Author:
Guillermo Castro H. Ph.D., Ciudad del Saber (City of Knowledge), Panama, M.Sc. Programme on Environmental Management, Department of Sociology, University of Panama. Panama.
Address: Apartado 89-9786, Zona 9, San Francisco, Panamá, R.P.
Telephone: (507) 317-0111 Fax: (507) 270 10 57
e-mail: gcastro@ciudaddelsaber.org.pa (office); mimu@sinfo.net (home).

Other contacts:
Adames, Abdiel, Ph.D.: abdieladames@cwpanama.net
Alvarado, Luis: Manager, Environmental Management Division, Division of Occupational Safety, Environment and Canal Protection, Panama Canal Authority, lalvarado@pancanal.com
Anguizola, Ricardo: General Administrator, National Environmental Authority, ranguizola@anam.gob.pa
Díaz, Juan H.: Director, Direction of Occupational Safety, Environment and Canal Protection, Panama Canal Authority, jdiaz@panacanal.com

Muschett, Daniel: Manager, Watersheds Management Section, Environmental Management Division, Division of Occupational Safety, Environment and Canal Protection, Panama Canal Authority, dmuschett@pancanal.com
Tarté, Rodrigo: Academic Director, City of Knowledge, rtarte@ciudaddelsaber.org.pa
Vallarino, Oscar: Executive Secretary, ICHW, ovallarino@pancanal.com
Vargas, Carlos: Manager, Meteorology and Hydrogrology Branch, Panama Canal Authority, cvargas@pancanal.com
Zárate, Manuel: Manager, Planeta Panamá Consultores, mzarate@planetaconsultores.com