São Paulo, Brazil.
Top left: Informal settlements in areas outside the city; top right: a roleplay game in action; middle: despite urban growth, agriculture remains important; bottom: Guarapiranga Reservoir.
Building capacities to tackle the infrastructural and environmental crisis in São Paulo: Role-playing games for participatory modelling

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“Foi bom sentir na pele como é ser enganado, não me informar direito (eu comprei terras que estavam sendo invadidas), a impotência diante de uma postura imprevista do prefeito e como é difícil ter uma visão global das coisas (lucro com agricultura irrigada e qualidade da bacia).”

“It was good to feel in my skin what it means to be cheated, not to be able to inform myself (I bought land that had been invaded by squatters), my impotence in front of the unexpected posture of the mayor and how difficult it is to have a global vision of the situation (for example of the benefit of irrigated agriculture or water quality in catchment areas).”

(A player’s comment at the end of a role-playing game)

São Paulo’s peri-urban problems

Peri-urban São Paulo is facing a serious water crisis. It is not for lack of rain – on average the area receives a comfortable 1,500 mm per year. It is also not for lack of institutions, water governance is embedded in highly institutionalised formal structures. Neither is it for lack of policies, since there are now highly progressive integrated land and water management policies in place. But conflicts between the main agencies, weak representation of local communities in the participatory bodies, large social inequalities and asymmetry of information and decision-making power make for a weak and ineffective implementation of land and water policy. As a consequence, water quality suffers, and adequate supply and sanitation services are lacking. To try and get the different actors around the table, the Negowat team in Brazil devised computer-based and real-life games. This chapter explains the background and experiences with this approach.

The Metropolitan Region of São Paulo (RMSP) is the most populated and industrialised region of Latin America, hosting some 18 millions inhabitants in a conurbation of 39 adjacent cities (Braga, 2000). The Alto Tietê catchment, upstream of the river Tietê includes most of metropolitan São Paulo.
Urbanisation processes have impacted enormously on the Alto Tietê catchment. As the river cannot supply all the domestic, industrial and agricultural water demand for such a large urban centre alone, half the domestic water supply (estimated at 61 m$^3$/s in total) is imported from the neighbouring Piracicaba Jundiai water basin (FUSP, 2001). Moreover, there is heavy demographic pressure on water resources: while population growth has fallen to 1.4% per year city-wide, the peripheral areas are continuing to grow at an average rate of 3 to 5% (FUSP, 2001). The water supply system in the metropolis, six centralised and interconnected production systems managed by a public-private enterprise, SABESP (Companhia de Saneamento Básico do Estado de São Paulo), is reaching its limits. Supply problems are anticipated by 2010 (Porto et al., 2003).

**Figure 4.1 Location of the Metropolitan Region of São Paulo within São Paulo State**
While drinking water distribution has an excellent coverage rate (close to 100%) in the regular urban areas, it is more precarious in peripheral areas. Moreover, except for the Cabeceiras-Tietê sub-catchment, water quality is low in the whole catchment area (Porto, 2003). The pollution that degrades the water bodies primarily comes from non-point sources, such as surface run-off and non-treated domestic effluent.

SABESP also manages a centralised system of sanitation: six large effluent treatment stations, which together cover most municipalities in the metropolis. However, the collection of domestic effluents remains incomplete. Despite recent investment, only an estimated 65% of effluent was collected and only 32% treated in 2000 (Porto, 2003). Domestic wastewater collection is especially low in the peri-urban areas, which are particularly affected by the rapid development of sub-standard settlements.

Social inequalities in Brazil are great and housing policies poor. As a consequence, poor people often see no other option but to settle on the margins of the city. Unfortunately these marginal areas also happen to be in the catchment headwater areas (mananciais) where springs arise. Ironically, the same legislation that aimed to protect the mananciais caused land values to fall, as all the land adjoining them
is public. This attracted many poor newcomers, leading to slum areas without water and sanitation services, and much human waste polluting the springs (Marcondes, 1999; Bellenzani, 2000). Almost an estimated million people have now settled in the protected areas of the municipality of São Paulo. In the remaining unsettled areas, a lively land market has developed.

**Legal progress**

To reduce pressure on the mananciais, water legislation has focused on their protection especially in the spring areas. In the beginning of the 1970s, a command-and-control type of legislation (*Lei de Proteção dos Mananciais*) was implemented to control land occupation and to protect the Alto Tietê catchment from polluting land uses. These measures however failed to significantly contain the urbanisation processes or reshape city growth (Marcondes, 1999; Bellenzani, 2000). Illegal settlements without sanitation infrastructure continued to spread. This led to a decrease in water quality in the main reservoirs, which growing competition between agencies and a corporatist vision of water management was ill-equipped to tackle (Prette, 2000).

In the 1980s, things seemed to take a turn for the better when Brazil adopted a policy of integrated water management, combining various legal instruments at federal and state level to facilitate management of water at catchment level. This takes into account different water uses and promotes participation of civil society in the management process. In each catchment, a river basin committee has been created as a discussion and consultation body, composed of representatives of the states, municipalities and civil society (local universities, local corporations, unions, local environmental NGOs, district associations, etc.) (Porto, 1999). A basin agency is in charge of implementing the specific measures elaborated by the basin committee. A specific funding agency (FEHIDRO) supports the agency, and will in due course be funded through water licence fees. As part of these policies, watercourses are classified into four classes with respect to water quality, according to their main uses, thus providing a mechanism to manage water quality. Because of the increasing complexity of water management, the Alto Tietê catchment is now divided into five sub-catchments, each with its own sub-committee (Figure 4.2).

In 1997, the federal law was reviewed to provide better coordination between water and land management to protect the springs. Municipalities were made responsible for land management. A federal City Statute or *Estatuto da Cidade* was adopted to try and reverse the urbanisation mechanisms in a different way. The legislation recommends the use of incentives rather than sanctions, and promotes new urban management practices ranging from participatory planning at municipal level to a process of legalising illegal settlements depending on the specific context of each case (Rolnik, 2001). But implementation of this legislation is very slow. Moreover, there is no real integrated regional policy related to metropolitan management in the Metropolitan Region of São Paulo. There remains at best a juxtaposition of various sectoral policies (transportation, housing, health, security). Sectors are not necessarily co-ordinated within
and between the different municipalities – with the possible exception of transportation policy, which is now defined at metropolitan level.

**Table 4.1 Land and water management instruments at different scales**

<table>
<thead>
<tr>
<th></th>
<th>Metropolitan level</th>
<th>Local</th>
<th>Microlocal level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water management</strong></td>
<td>Catchment planning</td>
<td>Sub catchment planning (by sub catchment committee)</td>
<td>Communities represented in the sub catchment committee and participative planning process at municipal level</td>
</tr>
<tr>
<td></td>
<td>(by the Alto Tietê catchment committee)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Land management</strong></td>
<td><em>Not really operational</em></td>
<td>Spring catchment protection instruments (planning, zoning) at sub catchment level</td>
<td>Municipal territorial and budget planning</td>
</tr>
</tbody>
</table>

The new water and land governance framework strengthens the need for discussion between different stakeholders and levels of management. But the efficacy of the legislation is undermined by functional difficulties faced by the committees. Their role as discussion platforms is weakened by important asymmetries in power and access to information between a fragmented and poorly represented civil society, powerful actors such as SABESP, and municipalities whose strategies are often driven by short-term electoral strategies (Neder, 2000; Ducrot *et al.*, 2003). These difficulties are common to any multi-stakeholder platforms, including the French Local Water Commissions on which the Brazilian *comitês de bacia* were modelled (Latour and Le-Bourhis, 1995; Cacquard, 2001). But they are all the more difficult to overcome in the metropolitan region of São Paulo, where inequalities in skills and political power are particularly large, and the key communities in the periphery are socially and economically marginalised.

**Peri-urban conflicts**

As in so many peri-urban areas, competition between multiple water uses, specific environmental challenges, the degree and speed of change, unclear governance frameworks, and the urgent need to develop specific urban infrastructure create a scene where *conflicts* are likely to emerge. In São Paulo, there are acute, if not necessarily open, tensions over:

- access to water and sanitation infrastructure, land speculation, and housing demand vs. control of pollution of surface waters,
- mining activities for the supply of building materials vs. agricultural land use,
- transportation infrastructure versus control of urbanisation and preservation of spring areas,
• joint water quantity and quality management (dilution of effluent or bad quality water, management of series of reservoirs) vs. increasing competitive demand.

This last point includes conflicts between the different agencies traditionally involved in water management (hydroelectricity, flood control, water supply, sanitation) over responsibility for the management of the reservoir systems.

The dominance of formal agencies in management and the complexity of the catchment and water system gives scientific information an important place in the management of the system. Authorities display a clear preference for engineering and technical solutions to resolve tensions and conflict. For example, when one of the few open conflicts in the area emerged, between mining and agricultural land use in the wetlands of Cabeceiras-Tietê catchment in 2002, the Municipality of Mogi das Cruzes asked a group of geologists to elaborate maps of the mining potential of the area as a definitive solution to the conflict. FEHIDRO funds specific scientific studies aiming to provide better or more detailed information and management plans are often conceived as scientific reports. This makes it particularly difficult for less informed representatives of civil society to participate.

Real involvement of stakeholders is even more difficult given that their main concerns relate more to securing land title and better housing conditions, household welfare, health, education, security and controlling violence, rather than to water preservation. Communities are afraid that they will be expelled from protected areas and most of the proposed solutions have difficulty in integrating their specific interests. Because the needs of the local population are so acute and diverse, the proposed solutions also find it hard to take into account the future development of the area, as well as solving on-going problems. As in the French Local Water Commissions or participatory management of collective schemes (Latour and Le-Bourhis, 1995; Le Gal et al., 2000), the challenge is to facilitate exchange and integrate people’s knowledge and representations, to understand different interests, and to facilitate the incorporation of possible futures in the collective discussion.

Research to facilitate dialogue
In the Brazilian Negowat project, we set out to develop methodologies and specific discussion tools to improve exchanges and support discussions. More specifically, we aimed to test the use of computerised role-playing games to support discussions on land and water management in two sub-catchments of the São Paulo Metropolitan Region: Guarapiranga and Cabeceiras.

In both areas, our methodology aimed to build a joint understanding of the issues in hand in a conceptual model that represented the social and biophysical dynamics involved. To deepen our understanding of the issues, we undertook a series of baseline thematic field studies. This led to the development of two specific intervention and discussion processes:
• *Teraguas* deals with land use and occupation at local levels and its impact on water resources quality.
• *AguAloca* focuses on water allocation and quality management at catchment level and its implications for agriculture.

Both processes developed specific tools and interventions, including computerised games and stakeholder workshops.

We wanted not only to test and develop tools and methodologies that facilitate discussion and knowledge sharing related to land and water management in peri-urban areas, but at the same time promote disciplinary integration and exchange of knowledge between scientists in different thematic areas and local stakeholders.

The Negowat team itself brought together an array of disciplines and actors from the public, private and civil-society domains, namely:

• research centres from two universities: the Institute of Advanced Studies of the University of São Paulo (IEA-USP), the post-graduate programme in Environmental Science (PROCAM-USP), the Faculty of Public Science (FSP-USP), the Polytechnic Complex Technology Laboratory (LTI-POLI-USP), and the Institute of Economy of the University of Campinas (NEA-IE-Unicamp),
• three laboratories from a state research institution on agriculture: the Institute of Agricultural Economy of the Agência Paulistana de Agronegócios e Tecnologias (IEA-APTA), the Agronomical Institute of Campinas (IAC-APTA) and the Fisheries Institute (Instituto da Pesca) of IP-APTA,
• one private water management research institute (AIIGEA),
• one NGO (Institute POLIS).

This diversity proved useful in supporting social learning not only among stakeholders, but also among ourselves.

**Role-playing games**

Brazil has experience with role-playing games built on the legacy of Paulo Freire (Freire, 1992), especially with psycho-socio-drama in the area of social intervention and local stakeholder capacity building. In the area of water management or environmental management of the urban fringe, the Negowat team identified various experiences that used role-playing games for capacity building. These games help to make the different interests of actors more explicit, and help participants from different backgrounds to experiment with negotiation processes (Ducrot *et al.*, 2006).

• ‘Governance’ games focusing on the discussion process have been developed and played to train high level-civil servants in planning and implementing negotiation processes in the field of public policy. Their elaboration necessitates a careful assessment of the role of power relationships in the control of information, institutions and natural resources.
• Various environmental education games have been developed and played to train local stakeholders on the use of new legislations and tools. The objective is often to train users in the best way to manage the environment.
• ‘Companion Modelling’ (ComMod) simulation games focus on the interaction between actors and resources (Collectif Commod, in press). This was the approach that inspired the games we developed and played in São Paulo.

Box 4.1  Companion modelling

Companion modelling (ComMod) is an approach based on social simulation in various forms (computer simulations, role-playing games) to understand and strengthen the collective decision-making process of stakeholders sharing a common resource. Simulation models integrate various stakeholders’ points of view and develop them as platforms for collective learning. Different stakeholders, scientists included, work out a common vision on resource management that can lead to new indicators, shared monitoring procedures, information systems and concrete alternatives for action.

The resulting three-stage cyclical process (see figure below) can be repeated as many times as needed:

• Field studies and research bring in relevant information and hypotheses for modelling and raise questions the model can help resolve.
• Modelling converts current knowledge into a formal tool that can be used as a simulator.
• Simulations, conducted according to an experimental protocol (either a computer model or role-playing game), challenge earlier understandings of the system and raise new questions for a new batch of field studies.

A Companion Modelling process approach makes the social, institutional and biophysical components of a situation explicit, builds joint representations, supported (in our case) by role-playing games and discussions on possible steps and approaches to solve the situation. More specifically a ComMod approach aims to:

• facilitate a better understanding of the roles various parties can play, and moves towards more common objectives (sustainable settlement in the mananciais area),
• discuss different ways of interacting and negotiating to enhance the effectiveness of negotiations over the medium term,
• introduce and discuss opportunities that the law enables, which rely on participation and collaborative work, and help participants jointly to identify ways to address problems in the short run.

Adapted from: www.commod.org
This work took place in two sub-catchments.

Figure 4.3 Location of the different sub-catchments and the municipality of São Paulo within the Metropolitan Region of São Paulo (external non-shaded part) and the Alto Tietê catchment (shaded part and sub area 1)

Figure 4.4 The Alto Tietê Catchment and the two sub-catchments selected by the Negowat project
Cotia-Guarapiranga

The sub-catchment of Cotia-Guarapiranga, an area of 905 km², covers seven different municipalities. It includes the Guarapiranga Reservoir which provides 15% of the domestic water supply for the metropolitan area and with a direct catchment area of 643 km². Home to 3.8 million people, this is the most densely populated catchment in São Paulo (4,275 inhabitants/km²) and one of the most severely affected by urbanisation. About 15% of the total catchment area is considered urban. The reservoir has suffered from high organic pollution rates since the 1970s mainly due to inadequate sanitation and wastewater collection in illegal settlements. To rehabilitate the reservoir, improve the quality of water and reduce treatment costs for water supply, an important investment programme, the Programa Guarapiranga, was implemented with the support of the International Development Bank in 1990. This programme was in itself quite innovative from an environmental, urban governance and institutional point of view (Marcondes, 1999; Bellenzani, 2000). In contrast to regional planning, it promoted inter-sectoral cooperation and discussion in a new form of integrated intervention at municipal level (Porto, 1999). However, it also gave priority to structural activities over participation, capacity building and support of economic activities. As an inevitable result, the programme did not manage to reduce water pollution in the catchment in the face of population pressure. However, it did allow the testing of some tools that were later included in the adapted legislation on mananciais and it promoted effective sectoral cooperation in the discussion of tools and legislation (Gondolo, 1996). It made it possible to elaborate one of the first models to simulate the impact of land use change on water quality (Mqual14) and to develop the first specific legislation for catchment management, the Specific Law of Guarapiranga15. After years of discussion, the law was finally approved by the state legislative in 2005 and is included in the new water framework.

After preliminary discussion with the Cotia-Guarapiranga Sub-Committee, we decided to focus our attention on raising awareness of the challenges in implementing the Guarapiranga law at local level in order to deal with the tensions between urbanisation, sanitation infrastructure development and control of water quality.

The objective became to elaborate a methodology, including discussion tools and role-playing games, that would allow different actors (representative of local communities, water firms, local municipalities, land markets, business and small rural owners) to make overtures to each other and initiate negotiations

14 Mqual model is a model that simulates the water quality of the Guarapiranga Reservoir depending on the land use and settlement patterns of the micro-catchments composing the Guarapiranga Catchment. It was developed during a previous development project and was used to define quality objectives for catchment management as part of Negowat research.

15 Lei Específica de Guarapiranga
and discussions on local urbanisation planning and development in a protected watershed. In response, we developed a specific process, Teraguas\textsuperscript{16}, in which we developed and played a computerised game, called Ter’Aguaas.

**The Cabeceiras-Tietê**

The Cabeceiras-Tietê Catchment is the biggest sub-catchment of the Alto Tietê. This 1,694 km\(^2\) watershed covers nine municipalities where 1.8 million people live at high-density: 1,101 inhabitants per km\(^2\). It includes the headwaters where the Tietê River rises. In total, 64\% is protected as a spring catchment area.

The catchment provides 10\% of domestic water supply for the metropolitan area thanks to two interconnected systems: the Rio Claro system and the Alto Tietê production system or SPAT (Sistema Produtor do Alto Tietê). The SPAT includes 3 reservoirs that were initially built for flood control purposes. Two other reservoirs are currently being filled to increase water production. This is the only metropolitan catchment where the agricultural sector is significant and is represented on the committee. A total of 8,000 ha is under irrigation, mostly by individually pumped surface water sources, while 20,200 ha are cultivated each year, mainly for horticultural crops. This cultivation requires an estimated abstraction of 2.56 m\(^3\)/s (Porto et al., 2003). Because there is such a high water demand in the city, the place of agriculture is now being questioned. Water quality in this system is better than in other catchment areas, but the quality of the water in the reservoir of Taíçubeba is steadily decreasing. There is no consensus about whether this could be due to the inflow of low quality water from another reservoir (Sendacz et al., 2005).

In this catchment, the Negowat project team decided to study multiple-use conflicts over water allocation, water quality management at catchment level, and the implications for agriculture in the catchment. It led to the development of a game, AguAloca, a series of workshops with farmers and a proposal for capacity building that could not completely be implemented during the game process.

\textsuperscript{16} Teraguas refers to the intervention process and Ter’Aguaas to the game.
Table 4.2 Summary of the two Negowat processes in São Paulo

<table>
<thead>
<tr>
<th></th>
<th>Teraguas Process</th>
<th>Agualoca Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of test</td>
<td>Guarapiranga sub-catchment</td>
<td>Cabeceiras-Tietê sub-catchment</td>
</tr>
<tr>
<td>Objectives</td>
<td>Discussion about land use planning and water infrastructure development.</td>
<td>Discussion on water allocation management in peri-urban area, taking into account agriculture.</td>
</tr>
<tr>
<td>Scales</td>
<td>Municipality/ Settlements</td>
<td>Catchment</td>
</tr>
<tr>
<td>Dynamics represented</td>
<td>Land market, land uses and urbanisation dynamics in protected area of Manancialias and impact on water resources quality.</td>
<td>Allocation of water between multiple users (inclusively small-scale agriculture) and impact of quality/quantity of resources where there are a multiple reservoirs</td>
</tr>
<tr>
<td>Intervention level</td>
<td>Micro local: communities Local: municipalities</td>
<td>Micro-local: small scale farmers Regional: sub-committee</td>
</tr>
</tbody>
</table>

Building games together with stakeholders

In São Paulo, the elaboration of the games was a key opportunity to integrate knowledge between scientists around a common question. Thus, rather than a simple exercise of tool development, we treated this development explicitly as a modelling process, to specify and make explicit the representations about interactions between actors and the resources in a given spatial territory. This required specifying and confronting how different participants perceive and represent the various social and biophysical dynamics, as well as selecting a type of representation that would make sense to all participants and include all potential players. To achieve this, we followed four steps:
1. Learning about the games,
2. Elaborating the models underlying the games,
3. Developing the materials and computer application,
4. Testing and validating the games together with users.

Learning about games

The first step was to learn more about the proposed methods, especially role-playing games for natural resources management. Some Brazilian experiences were assessed and compared (Ducrot et al., 2006). A theoretical computerised role-playing game called JogoMan was elaborated to train partners in the development of computerised role-playing games (Adamatti et al., 2004; Adamatti et al., 2005) and in how to implement and monitor such games (Camargo, 2006).
Box 4.2 JogoMan

JogoMan is a computerised game that simulates the functioning of a peri-urban catchment area facing rapid water resource quality degradation due to urbanisation and inadequate sanitation arrangements. The game includes two or three territorial municipalities, and thus two or three mayors, (instead of just one as in Ter’Aguas) and 7 to 15 private landowners depending on the version of the game. Land owners can only choose between four types of land use (forest, agriculture, industry and settlement/urbanisation). Population dynamics are much simpler than in Ter’Aguas, and there is a specific role for migrants looking for cheap housing, which does not exist in Ter’Aguas. The spatial basis is abstract and very simplified.

The modelling process and testing the game with students underscored the need to specify more exactly some of the processes and strategies. Scientists in the field of hydrology, agricultural economics, and social sciences carried out specific research studies. The results led to a series of thematic reports and papers. It also contributed to the elaboration of a general conceptual framework we built through a series of internal workshops. Regular interactions with the Bolivian team provided other important opportunities for partners to discuss the team’s theoretical, methodological framework as well as the institutional, political and environmental dynamics of the peri-urban catchments in each country. In spite, or maybe even because of, the differences between situations in Brazil and Bolivia, these interactions helped the Brazilian team to identify better the specificities of the Brazilian dynamics and of their conceptual basis. We used the results of the studies and meetings to develop the Ter’Aguas and AguAloca games.

Elaborating the models underlying the games

For each process (Teraguas and Agualoca), a work group was responsible for developing an underlying model that could represent the interactions between the social and biophysical dynamics, and that real actors could use as a virtual negotiation platform. The underlying model of each game specifies the relationship between the resources, their dynamics and the actors, and it indicates the different ‘spheres of action and decision making’ for each actor. These include tasks, indicators and the information necessary to make decisions, the main relationships with other actors, their frame of reference in terms of time and space, their main concerns regarding natural resources management, and the reciprocal interactions between actors and the resources. To build it, we used the methodology ‘actors-resources-interaction’ proposed by the Companion Modelling group.

For both of these two main games Negowat decided to formalise the natural dynamics with the help of IT, which resulted in a computer-based game, designed with Cormas (Common-Pool Resources and Multi-Agent Systems) multi-agent software (see http://cormas.cirad.fr) (Bousquet et al., 1998). As explored in Box 4.3, the use of computers in role-playing games has various advantages and drawbacks. It was particularly useful in the cases studied in Brazil to represent water flows and changes in water quality that otherwise would be difficult to represent.
Figure 4.5 Part of the collectively built model underlying the AguAloca game

The groups that elaborated these models were composed of scientists involved in the Negowat project. To take better account of other representation and knowledge, we involved other key stakeholders. For the Ter’aguas game, we held a series of eight workshops about urbanisation and environmental issues with a small group of representatives from local communities. For the AguAloca game, we presented and discussed the assumptions underlying the game and its model with representatives of the sub-committee in two meetings. We had further direct discussions with some of the representatives to specify relevant strategies and indicators.

Developing the game materials and computer applications

As a next step, we developed the game materials (board, roles, rules, cards) based on the underlying model. We needed to specify the time and space units we would use, which roles there were, what activities are associated with each role, on the basis of the actions and decision-making process identified for each actor and the information and indicator needed. After that the game materials (board, cards etc) were designed. In the case of ComMod (Companion Modelling) games, the spatial aspect (playing with a map) is very important as it not only serves to help players to internalise their role but it also supports the environmental dynamics (water flows, transformation of land use) and changes.

Testing and validating the games

The first test, conducted with members of the team and graduate and postgraduate students in environmental management was aimed purely at assessing whether the game could be played (clarity of materials, etc.) and whether it was dynamic and enjoyable enough to play. The student tests highlighted a need to simplify the Ter’ Aguas game materials, notably to change the territory from 900 ha territory to 180 ha.
Box 4.3  Computerised game versus non-computerised game

Computerised games facilitate the realisation of complex tasks and calculations, such as rapid assessment of resources dynamics, or economic balances. They can represent complex resources dynamics, for example water flows or pollution diffusion. The computer makes it easy to monitor and review a game session, as one can keep track of all the different steps and decision-making elements. This can facilitate discussion during debriefing, or allow players to explore how different strategic choices could lead to different developments.

Computerised games also have weaknesses. They can to some users seem like “a black box” for users that gives magic answers, and they lack flexibility as options and possible solutions are limited by the alternatives into the computer model. Understanding and filling the interface between players and computers can also pose problems.

We can think of solutions to remedy such problems, for example, a first turn when all calculations are done by hand (to avoid the black box effect), or by collective elaboration of the game to be sure that everyone understands its contents. One could also introduce “on the spot” innovative solutions in a computerised session but this requires very good knowledge of the detailed content of the software and underlying rules. Such drawbacks can sometimes be compensated for by adequate facilitation.

Non-computer-based games are not necessarily easier to play. What makes the difference is:

- the true-to-life quality of the game in relation to the decision-making process,
- the enjoyability of the game (calculation by hand can be too slow or less interesting than a computerised game),
- the facilitation support,
- collective preparatory work before the game.

The key test is the validation of the underlying model by users. To this end, a small group of stakeholders well known to the game developers, played the games, each taking their own real-life role. This test aimed to validate the general and individual representation of each role, the indicators, and the rules of interaction. The focus group from Parelheiros helped us test two games: the non-computer game JogoPol (Box 4.4) and the Ter’Aguas game. The validation of the Ter’Aguas game not only gathered representatives from the district (the focus group itself) but also representatives of the Municipality, the water company and the local business sector. A first discussion group with representatives from Parelheiros region (Municipality of São Paulo) helped us develop the game itself and validate the representation of reality.
Box 4.4 JogoPol, a non-computerised game that did not prove so useful

The JogoPol game is a non-computerised game that rests on the same underlying model as Ter’Aguas but uses coloured balls to represent pollution and colour cards to represent land use (3 types of land use, compared with 15 in Ter’Aguas). It was designed to be played by local actors and so avoided the need for players to have to read and write. However, the manipulation of the balls made this game particularly slow, not so easy to play and not dynamic enough. As a result, the game was not considered good enough to facilitate discussion and multi-stakeholder interaction.

In these first workshops, local dwellers tended to focus on the most visible part of the problem (for example, garbage in rivers, rat infestation). Even when the links between health and pollution were acknowledged, many related it only to these obvious pollution sources rather than to the diffuse domestic pollution which our baseline assessment showed to be the main problem. It also emerged from the workshops that the local residents distrust the Government, Municipality and water company, demand better living standards and strongly desire to be better informed about legal issues that would allow people to regularise their situations.

The comments of these players, who were also real life participants in these issues, led the team to modify the representation of districts and to incorporate new functions that were not initially included, such as the drilling of artesian wells. Also, in order to involve the players in a more collective dynamic, the collective discussion that originally occurred after the first turn was reallocated to the beginning of the game.

Role-playing games for capacity building: the Teraguas process

To involve all the different real-life actors, the Negowat team proposed a multi-step methodology (see Box 4.5), including playing the game with representatives of the Municipality, local residents and the water firm. The Teraguas process is therefore shorthand for a sequence of workshops, including a session to play the Ter’Aguas game.

We implemented the process in its full extent in two districts (Figure 4.6): in Parelheiros, where the objective was strengthening the capacity of local stakeholders in negotiations related to urban infrastructure development, especially sanitation, and in the northern part of Embu-Guaçu with the objective of preparing local stakeholders to participate in a local-level municipal planning process.
Box 4.5 The Ter’Aguas game

Ter’Aguas is a computerised role-playing game used to simulate negotiations related to land use planning in a peri-urban municipality. It is based upon the Specific Law of Guarapiranga. Six types of actors are represented: a municipality mayor in charge of the development of urban infrastructure (roads, school, health centre etc); a water company in charge of the development of water and sanitation infrastructure; four district representatives defending the interests of local dwellers (different types of district in terms of access, type of settlement, homogeneity, proximity to rivers); two small farmers in the surroundings of the district; two big landowners with speculative and electoral strategies; and one weekend house owner who also defends environmental issues in the catchment.

The players take decisions concerning investment strategies in urban infrastructure or water and sanitation, subvention and taxes on land, buying and selling plots, developing property, land-use activity, licensing land uses and activities, and allocating land to migrating families in the area. The computer simulation rapidly assesses the impact of land-use changes on reservoir water quality (with the help of an adapted version of the Mqual model), on the cash assets of players, social indicators (employment) in the municipality and eventually the settlement of migrating families. After a round of decision-making, all players gather to try to find a more collective planning strategy and try to implement it the following round. The interactions can focus on strategies for urbanisation, investment in urban infrastructure (sanitation, piping, wells, roads, etc), land-use planning and land market dynamics.

Figure 4.6 Location of Parelheiros and Embu-Guaçu
Box 4.6  Methodology for Teraguas

A series of 7 activities held during 4 or 5 workshops:

- Map the relationships between resources (land, water, housing, urban infrastructure) in each settlement and compare settlements to identify similarities and differences.
- Reconstruct the development of settlements and the history of the present situation in order to introduce the dynamics of resource relationships.
- Reconstruct a simplified version of the mechanisms of dynamics (for example land market or land use) (This activity was only implemented once).
- Map the actors, responsibilities and activities (legal or illegal) relating to resources.
- Rapidly stage a situation close to the issue, adapting the game situation (role description) from a pre-existing game, Desafios das Aguas, in order to introduce multi-party negotiations.
- Play the Ter’Aguas games followed by a debriefing. This helped to connect all previous elements, provide a dynamic view of the situation at regional level, and experiment with new attitudes and solutions.
- Carry out action planning or negotiation planning related to the selected issues. This helped stakeholders to prepare a specific action or negotiation and to identify further information needs, mobilisation needs, actors, etc.

The Teraguas process in São Paulo was intended to support the rapprochement of various stakeholders interested in the local planning and development process in a protected peri-urban catchment area. It was designed to build the capacities of local stakeholders in related negotiation processes and to help them assess some possible alternative local and shared solutions and to contribute to water quality preservation in the mananciais, taking advantage of the possibilities offered by the new law.

We found there to be almost no tradition of participatory interventions in these peri-urban areas and little previous communication between representatives of government and research institutions. In each case, residents said that the Negowat intervention was the first direct contact with research they had the opportunity to become involved with. The real-life role of residents’ representatives is generally limited to listening to presentations of plans or explanations from the water company or the municipality, while the Government’s approach is often one of paternalism. Local municipalities lack the financial and human resources to hold in-depth discussions with local communities. Local residents’ associations, for their part, have little interaction with one another, and instead compete strongly to get greater material advantages from the municipality. They tend to develop a political discourse that is not well grounded in reality. In such a context, promoting a real dialogue between these actors on a complex issue was particularly challenging.
Table 4.3 Summary of Teraguas process and Ter’Aguas game

<table>
<thead>
<tr>
<th>Focus Group Parelheiros</th>
<th>Number of test games (Ter’Aguas game on its own)</th>
<th>Complete Teraguas process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embu-Guaçu (Municipal land planning)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Parelheiros settlements (Conflict on sanitation)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Guarapiranga Catchment Sub-Committee</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

In this social context, a game like Ter’Aguas provides a unique opportunity for local representatives to meet other actors. However, it was difficult for them to distance themselves from their every-day reality and to get into the game in the presence of these other actors. During the first part of the test, the district representatives took this opportunity of meeting high-level representatives of the SABESP water company and the Municipality to express real-life demands and needs, using their traditional way of interaction, and this put an end to the first round of the game itself. They started to understand that other interests and purposes may surface in a second round of the game but unfortunately, there was not enough time to complete it in the same session.

They decided to play on another occasion, asking for a simplified version of the maps. When the second test was done one month later, not everybody who had participated in the first game was again able to be there, while there were also new players. This time we purposely inverted the roles. This was interesting for players who had already played the game, but was resented by new players who found it hard to play their non real-life parts. The game did, however, lead to rich discussions about legalisation and negotiation processes and permitted players to discuss the attitudes and behaviour of parties during negotiations.

The members of the Guarapiranga Sub-Catchment Committee also played the game, mainly with representatives of municipalities, government (Environment and Housing), water companies and the main environmental NGO. Two local representatives came from an urban part of the catchment (São Paulo). As the sub-committee had been involved in the elaboration of the detailed contents of the Specific Law of Guarapiranga over the previous six months, we expected the game to be an opportunity to test the implementation of this law. Because the members of the committee were supposed to have excellent knowledge of the complex situations and mechanisms involved we inverted the roles. The two representatives of local communities (along with other people) were assigned a role as mayor and water company manager. People from government institutions...
represented the local representatives. The game was very dynamic and eventful but the discussions were very different from what we had observed in the other games. They focused on an agreement with the business sector, played by an NGO representative with a very strong personality, who never mentioned the land regulation issue, which had been the main focus of discussions in other games. In this game, the players attributed difficulties in land planning to lack of control and monitoring, but made no collective effort to organise themselves to take care of monitoring or to use economic, social or investment mechanisms to shape the urbanisation process.

Local planning in the Municipality of Embu-Guaçu

We proposed to representatives of the Embu-Guaçu Municipality that they use the Teraguas methodology to strengthen the capacity of local leaders to engage in a new municipal planning process. Unfortunately, we were unable to develop these activities before the ‘participatory’ discussions started as part of the planning process. Thus, the Teraguas process took place in parallel with (and after) these consultations. We took care to plan the Teraguas activities, five meetings over two and a half months, so that they did not clash with the six meetings the Municipality organised on the Municipal master plan. It must be said that the more formal consultation process was not successful. Few representatives attended the public consultation carried out by the municipality. Lack of interest, combined with lack of information in what was supposed to be a planning process and a municipal organisation that was not really adapted to involvement of the public can explain why this participation was so weak.

We decided, together with the Municipality, to work in the northern part of the Municipality, in a remote area that has to contend with an influx of illegal settlements from the adjacent M’Boi Mirim area of the Municipality of São Paulo, close to the reservoir. We could not identify any residents’ organisations. The Municipality suggested we work with health agents who act as intermediaries for activities in this area. Health agents are part of the municipal health movement that aims to decentralise health services in each settlement recruiting and training local people.

The health agents indeed showed a keen interest in water management issues, especially in access to clean water and sanitation as these are closely related to health. They had had little previous opportunity to discuss the origins of pollution or the related problems and dynamics, even if they sensed it was important for their interaction with local communities. Two local NGOs also joined the group but other movements or organisations did not participate.

The last meeting was devoted to a presentation of the main elements of the Municipal master plan, its relationship with the specific law of Guarapiranga and the opportunities it might offer in term of legalising settlements and access to infrastructure.
The water company, SABESP, was not represented during the game but the Municipality participated as did a former representative of the planning service and representatives of the agricultural services. The game was playful and dynamic and the agents who had participated in earlier workshops did not report any difficulties in playing or understanding the game.

A first assessment indicated that participants in previous workshops benefited from collective learning about what negotiation means in terms of mutual benefits, understanding different interests, the need to come to the table with some prepared proposals for solutions and, finally, how to integrate a more global vision of development issues with the interests of people living in the settlements.

The group of health agents managed a more successful interaction with the authorities, which is very necessary as they struggle to upgrade services and improve the quality of life in their settlements. In the real world, the Municipality and public authority are very difficult to get hold of, while the Municipality finds it hard to implement a really participatory process to elaborate the master plan. The interest of the health agents was not limited to the content we provided (knowledge and information concerning the relationship between land use and occupation, spring protection, water management, information on the legislation); they also engaged with the methodology. Subsequently, the supervisor of the health officers asked us to provide formal guidelines for the method, so that they could adapt them in their work on health issues with local people.

**Negotiating infrastructure development in the district of Parelheiros**

At the request of Parelheiros, a district on the southern tip of São Paulo City, (pop. 200,000), we developed an intervention to help resolve a conflict over sanitation infrastructure. Three settlements in the area had recently gained access to drinking water thanks to a new decentralised water system based upon an artesian well and managed by SABESP. This system was constructed after a judicial order that the settlements were entitled to water services, as they had been legalised twenty years ago. However, no sanitation service had been planned and SABESP and the district authorities were willing to promote the use of septic tanks in order to avoid pollution. The slum dwellers resisted this option as being expensive, technically not suitable and more difficult to manage than a sanitation network that is perceived as the ‘normal’ sanitation option in a place. In the context of this disagreement, the Municipality asked the project team to help out, believing that a communication exercise could facilitate the implementation of the technical solution they proposed. Although this was not open conflict as has happened in Bolivia, there were strong tensions and a complete lack of trust between the settlements and the Municipality.

A sequence of four meetings was held, one every Saturday, mainly with district representatives, members of the settlement organisation and some individuals, making a core group of at least 10; and sometimes up to 17 people. Although
the involvement and competence of individual representatives was recognised, many participants lamented a lack of connection between residents and their representatives, and a lack of involvement by residents in any collective action on their immediate interests. The Municipality was represented in only two meetings, including the Ter’aguas game. A couple of people were afraid that the meetings would be followed by their expulsion, a major fear of people in the area who are insecure about their land title and are more or less aware of settling illegally in a protected environmental area.

It was not possible to find detailed alternative solutions to improve sanitation and the related negotiation process, but during the last session, some interesting proposals started to be discussed. All participants understood the possibility of collective solutions, for example by creating partnerships between SABESP, the Municipality and the communities to share the investment costs of individual sceptic tanks, and eventually the maintenance costs as well. The process also allowed participants to reflect on and discuss how they interact with the local authority, and to point out possible ways to elaborate collective solutions. It shed new light on stakeholder attitudes and modes of negotiation and gave them the opportunity to discuss various aspects of negotiation: ‘free riding’ (by people who benefit from negotiations without playing any role in achieving it), monitoring an agreement, handling and using information in argumentation, assessing one’s role and responsibilities, and the constraints of different parties. The process was also an important moment for rapprochement between opposing parties.

**First lessons learned from the Teraguas process**

It has not been possible to implement a complete assessment of the sequence of work before the end of the project, so we are presenting only our preliminary views.

The sequence of work was organised so that local representatives might change the way they interact with other actors and present a more global view of the issue of land and water at local level. The first step, a description of district development and problems, was important for representatives, as it gave them a platform to express and clarify their grievances and complaints. It helped them to understand the similarities between their problems and those of other stakeholders and to initiate a discussion about how housing development and land and water resources are interrelated. The subsequent steps helped them to link and better understand the role of different actors, of which they have had a very fragmented view. We chose to introduce negotiation through a small and simplified dramatisation that does not require any specific support, just a rapid description of roles. It helped the players to think about the contents of a negotiation and which attitudes can help or hurt negotiations. For example, settlers often tend to be passive when confronted with a paternalistic attitude on the part of authorities. This has often led settlers to accept any answer without clear justification or argumentation, and to abort discussions, especially since their own argumentation is generally not well constructed or informed. This
simplified drama also helped to prepare them for a more complex simulation when they face representatives of other parties, whom they are not used to meeting on such an equal footing.

The Ter’Agua game makes the links between actors’ decision-making processes and resource dynamics (housing development, pollution,...) and simulates collective action. As in the previous workshops, the Ter’Agua game was dynamic, playful and constructive. This happy result was not necessarily what we expected, as the workings of a computerised game are far from simple. To make things as easy as possible, we made it possible for the players to concentrate on decision-making and strategy elaboration while project facilitators took care of filling out the instruction sheet. This proved to be a good way to work with the players, even those with very basic education, and allowed a dynamic game to progress in spite of the apparent complexity. The complexity is in fact relative, as the game deals with normal, every-day activities of the players. Once the rules were clear and players made the connection with their own situation, they quickly identified themselves with their role and activities. The participants did not report any difficulties that could not be overcome after the first (learning) round, apart from one or two people who needed two rounds. However, the game clearly would not have been so successful without the previous workshops.

Our first assessment indicated that the game helped players to make sense of their situations and discuss how their decisions affect resources and the lives of other players. It helped them to better understand the roles, responsibilities, interests and positions of other players and to open up avenues to non-traditional modes of interaction. The final step would have been to use what had been learned during this process to elaborate new negotiation strategies on specific issues. Sadly, we could not accompany this group further in the full development and implementation of these strategies within the project’s time frame. The key problem was to mobilise other actors, especially relevant representatives of the Municipality, of agriculture and especially of landowners. Many municipalities in the area have few human resources; it proved very difficult to mobilise them for our game. A paternalistic attitude on the part of some representatives obviously prevents real involvement in this kind of group dynamic.

Our methodology helped to build capacity among local representatives in the process of negotiation about infrastructure development around a protected spring catchment. But the process also showed up many problems that may stand in the way of constructive collective action. Existing organisations are weak, not well structured and attract little support from local people. In areas characterised by migration and high mobility, there is often no formal organisation and leadership remains weak. The population is often not closely involved in collective action, either because of a lack of a sense of community or as a result of engrained attitudes toward authorities. Actions to ‘upgrade’ the district are often the concern of just one or two people. If they are linked to local political interests, this only gives rise to further internal conflict. Some of these politics are
clearly related to local private interests. Representatives report a general lack of information about or interest in the spring catchment area. We would need to use other methodologies to raise awareness among local dwellers and mobilise their representatives.

For us, one of the most interesting results was the difference between the games played with ‘real actors’ and those played with the Sub-Catchment Committee representatives. Land legalisation was not tackled even once as an issue in the Committee, while most of the discussions with the real actors were about this issue. We found it significant that there was a clear orientation to seek external control and monitoring functions to control planning. During the discussion, the players said that if they did not succeed in controlling urbanisation, it was because there was no role in the game representing ‘environmental police’ in charge of monitoring settlements in the area. We had purposely declined to create such a role in the game to see if the players were able to organise this monitoring and control collectively (say, by making one player responsible for this) or would leave it to the free market (land speculation). The first immediate reaction of players in the game however was to look for a ‘master’ controller, which seems to suggest that they did not see urbanisation as a collective problem but as something external that you cannot possibly control. This seems to reflect a rather static, instrumental and top-down view of governance, in which planning is not an objective or a process, but an instrument. This could be illustrative of the distance between lawmakers and everyday reality, and the institutional actors’ difficulties in integrating the dynamics of urbanisation, which they know about at theoretical level but find hard to put into practice. The committee also appeared to be badly prepared for the new specific law: even its designers had difficulties in working with it to tackle urbanisation and pollution control.

In summary, the Teraguas process was implemented twice in the Guarapiranga catchment. Thus the game was played four times with local actors (twice as part of the Teraguas process and twice as a test for validation of the game). It was played once with the Sub-Committee of Guarapiranga. But Teraguas deals only with local planning issues. We also tested the type of approach with management of water at catchment level by developing a specific process named AguAloca in another peri-urban watershed (the Cabeiceras Tietê Basin).

**The AguAloca process**
The second process developed by Negowat called AguAloca (Box 4.7) aimed to help stakeholders to take the water quality aspect of catchment management into account, and to contribute to a dialogue for a better integration of agricultural activities in catchment development and policy in another area, the Cabeiceras Tietê Catchment. We organised two main activities. We worked with farmers on the relationship between farming and the environment (especially water) and started a discussion about good practice for water quantity and quality. We also worked with members of the sub-committee, playing role-playing games to integrate water quality and quantity issues at catchment level.
Supporting better involvement of farmers with water issues

We organised workshops to strengthen the ability of the farmers’ organisation to deal with the looming water crisis and to support collective management. We focused on multi-functional land use in agriculture as a potential strategy for the Alto Tietê Cabeceiras Committee management policy. The workshops sought to present this new perspective and to initiate a participatory appraisal of three technical issues: rationalising water use for irrigation, best practice on applying agricultural inputs, and pollution control. Finally, we set out to craft a farmer organisation willing to propose a programme to promote ‘environmentally friendly agriculture’ in the water committee, and to promote gradual change towards technological ‘greening’.

We selected four areas where there was already an existing micro-catchment project. A community leader was made responsible for organising the local structure and for inviting farmers to the workshops. Economic studies on market conditions and the economic viability of ten production systems had previously been carried out, and these findings were presented at our workshop to stimulate farmers to broaden their perspectives on local activities, and potential benefits and constraints. With an average of 15 farmers in each workshop, we discussed how to develop a local water-friendly eco-label and a social control system for guaranteeing quality. For technical information on agrochemicals we could refer to a course they had previously engaged in and to the best practice handbook promoted by the Associação Nacional de Defensivos Agrícolas (ANDEF). However, it soon became clear that we also needed training days, specifically on irrigation system management. On the basis of these workshops, a set of rules and procedures was defined based on existing or easily adopted practices. A final meeting was planned to integrate each micro-catchment proposal into a regional set. An invitation was made to the water committee to bring it up to speed about this proposal.

Taking an action-research perspective, we aimed to show that agriculture could play an important environmental role in preserving adequate conditions for water production. We set up a series of participatory workshops to involve small-scale farmers and evaluate their interest in introducing the necessary technological changes to promote agriculture as an environmental service in a participatory way. In the workshops, we presented a set of suggestions to stimulate discussion and summarised ideas on cards which were discussed until a consensus was formed. At the end of each meeting a list of common rules and procedures was affixed to the wall, and was read out and approved by the whole group. The experience showed that it is eminently possible to integrate small-scale farmers into the process and also how necessary it is to develop proper conditions for technological change. These conditions include training field days, legal land-use issues, access to proper financial resources, technical issues and others. As the workshop progressed, we saw an increase in the number of small-scale farmers in the workshops and we saw an increasing willingness for people to present their perspectives.
We needed to adapt our strategy, however. The initial proposal was to stimulate interest in the water issue by appealing to the economic interests of small-scale farmers. However, economic evaluation of different production systems proved a hard task, due to the complexity of these systems and the lack of any interesting new information that they did not already know intuitively. Far from the workshops stimulating the farmers, we witnessed the number of participants dwindle steadily. In one case, one activity even led to a conflict with some farmers who were involved in purchasing local products for supermarkets. As a consequence, one group decided not to participate in any further workshops, although they changed their minds when draft rules and procedures that had been discussed by other groups became available. On the plus side, the discussion of environmental issues and the possibility of attracting customers with the help of an eco-label was highly appreciated. This was the first time that such a proposal had been put to the farmers.

Together with farmer representatives, we built a water-scarcity scenario supported by information about per capita water availability in the Metropolitan Region of São Paulo. This demonstrated the region’s strategic role in increasing availability within the watershed and its dependency on neighbouring watersheds. The role of farmers as potential guardian of water resources was discussed as a basis for improving land and water management practices. At the time of writing, the negotiation process had not yet started and the product of these efforts was dependent on water committee interest and financial support.

**Helping committee representatives integrate quality at catchment management level with a game**

While one group worked with farmer committees, agricultural and rural specialists on the Negowat team became involved in discussions promoted by the Guarapiranga Sub-Catchment Committee, to detail the rural management aspects of the Specific Law for Guarapiranga. Internal differences within public agencies had led to the development of a revised proposal which led some municipalities in turn to propose a third alternative. At the time of writing, the sub-committee was trying to merge two proposals.

As this was unfolding, we developed the Agualoca game to help the Cabeceiras-Tietê Catchment Committee strengthen individual and collective knowledge about the physical and social processes that affect water quantity and quality at catchment scale, and to contribute to a discussion about the role and place of agriculture in the catchment development.

The game represents the relationship between quantity and quality of water resources at catchment scale. In a peri-urban headwater catchment, this relationship is the result of the water system management at catchment or wider scale (management of dams and transfers of water); the local actions of each stakeholder (irrigated agriculture, industry); and the management of local land use. It was important to represent the relationship between these different elements and, after some
deliberation, we opted for a computer-based representation (simulation model). We needed a model that could represent both dimensions (quantity and quality) at catchment scale as well as at the level of individual users.

Here, it gets a little technical. Generally, water allocation models show arcs and nodes that represent flows (rivers, channels) and specific points (confluences, pumping stations, dams). Some key stakeholders of the Cabeceiras-Tietê Sub-Catchment are used to an allocation model called AQUANET (Porto et al., 2003) developed to support the management of the complex system of dams of the Alto Tietê catchment, so we decided to take inspiration for our allocation model from this tool. There are also various other kinds of water quality models dealing with different issues: diffuse pollution, contribution of tributaries, dam pollution. In our case, the purpose was to show in an insightful way the mechanisms that occur in the Cabeceiras-Tietê Sub-Catchment. We decided to focus on the concentration of phosphorus in water bodies, as this is the key limiting factor for eutrophication in Brazil (Salas e Martino, 1991, cited in Von Sperling, 1996). The catchment was first divided into ten sub-catchments. Each sub-catchment module calculates a phosphorus contribution from its land use following the coefficient of an existing simulation model (Mqual of Guarapiranga) and transmits it to a specific node of the allocation model. Then the model calculates the exponential decrease of the concentration of the phosphorus following the AQUANET model quality functions. In the model, dams are specific nodes that use the Vollenweider model to predict their phosphorus concentration (Von Sperling, 1996; Jørgensen, 2000).

The way we represented the system had various limits. In particular only three land uses are represented. Moreover, it does not show the complexity of dam water quality, as in the model the effects of phosphorus remain constant while in real life they are normally proportional to the intensity of precipitation. Nevertheless, this skeleton proved sufficient to demonstrate within a game the main trends of the relationships between water quantity and quality at catchment scale, including phosphorus coming from dams, phosphorus contributions from urban areas (with or without sewage collection), and upstream-downstream transport of pollution loads. In this way, the impact of decision-making by all key actors can be taken into account in a negotiation process.

As the project team developed the game, we also developed our own capacity. The elaboration of the underlying model enabled us to synthesise different Negowat lines of work. This contributed to a better understanding of the complex water dynamics (quantitative and qualitative) in a peri-urban headwater catchment, such that the non-water specialists in the team could also work with it. Some

17 The Vollenweider model is an empirical model developed (indeed by Vollenweider) in 1969 to assess the phosphorus concentration in a reservoir as a function of (1) the phosphorus charge generated by the land use in the related drainage area of the reservoir, (2) retention time in the reservoir (Jørgensen, 2000; Von Sperling, 1996).
issues were however left out because of time scale (impact of cold fronts on dam quality) or because of the complexity of the process (fish farming).

We tried to make the game a virtual discussion platform, and many players appreciated that the game made complex issues and dynamics much easier to understand.

**Playing the AguAloca game**

To test and validate the game, we first played with a group of key participants in the sub-committee. This validated the basic principles, but we decided to reorganise the timing of the collective discussion and to simplify the rules, as players reported difficulties internalising so much information.

After these adjustments, we played the AguAloca game with SABESP engineers and representatives of local municipalities, with representatives of the Alto Tietê Water Agency and three times with students. A game was planned with the technical planning unit of the Sub-Committee of Cabeceiras Tietê.

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**Box 4.7 The AguAloca Game**

The AguAloca game is a computer-based role-playing game, developed with the multi-agent software Cormas. It aims to simulate negotiations related to water allocation and its impact on water resource quality at catchment level. The environmental setting was based upon the Alto Tietê Cabeceiras Sub-Catchment. This peri-urban Catchment includes multiple and competitive uses of water influenced by the vicinity of the Metropolitan Region. The game contains two municipalities (one typically peri-urban and the other still very rural, a strong irrigated agriculture sector, and industrial activity, with a complex hydraulic management system (3 dams, 2 transfer canals) which aims to protect a downstream metropolitan region from flooding and to supply domestic water to the metropolitan region. Five types of actor are represented within the game, which requires six players. The two mayors of the municipalities have to guarantee access to water services for their inhabitants. One operates the water services system while the other grants a concession to the company in charge of the Metropolitan water supply. The water company has to supply water to the whole Metropolitan Region. The farmers’ delegate has to defend irrigation interests while the industry delegate operates two paper manufacturing plants. The Catchment Water Department has to operate the complex hydraulic system respecting the users’ water rights. The players make their decisions every six months just before the rainy season or the dry season, taking into account production objectives, pumping processes, and effluent treatment processes. The model quickly translates these decisions into water demand (quality and quantity), water effluent (quality and quantity) and water satisfaction, i.e. whether demand is met (quality and quantity).
A first analysis underlined that the game has good potential to include agriculture at the centre of a discussion, either as an activity affected by water management at catchment level or as a potentially polluting activity. A lot depends on the involvement of the ‘farmers’ representative’ role. At each session we also held discussions about the role and place of farming in catchment management or in infrastructure development in more rural areas. We discovered that many stakeholders are uninformed about agricultural activities.

Analysis of the sessions also indicated that games do contribute new and concrete insights into what is meant by ‘integrated or shared water management’ or ‘collective action related to water management’. They drew out the underlying interactions between different activities at catchment level and allowed the players to understand better the interests of other stakeholders. They also increased players’ knowledge about how the quantity and quality of water resources are interrelated at catchment level. This is particularly true for stakeholders who arrived with a strong interest in water management, which they initially always expressed in terms of quantity. As their knowledge increased, some players started to investigate the biophysical model. For example, one player in charge of the management hydraulic system tried to mix his water allocation model skills with the quality option model so as to dilute effluent. Other examples were industries that decided not to treat their effluents in order to see the impact on water quality downstream, or the participant playing the farmer representative, who tried to promote rural sanitation in order to assess the potential impact on water quality. This especially caught the interest of some technicians from the SABESP team in charge of the drinking water plant in Taïçubepa, who requested a detailed conversation with the Negowat water quality specialist to help them better understand the underlying dynamics and how they could incorporate these principles into their real life daily practice.

The game also led some players to investigate the relationships between water management and urban planning. However, the highly simplified representation of land use and population dynamics in the AguAloca game (compared to the more sophisticated representation in Ter’Aguas) led to some frustration on the part of the planners. Another source of frustration stemmed from their rather mechanical vision of land planning and urbanisation control. Once an agreed zoning policy was in place, municipal players expected the (simulated) ‘people’ to act exactly according to planning. But the software does not necessarily take into account the zoning planners had selected – and neither do real people. It would be interesting to follow an AguAloca game session with a Ter’Aguas game to discuss the issue of land planning in more detail.

The game not only turned out to be particularly enjoyable and mobilising, many participants also emphasised the quality of the support it provides for discussions about catchment issues. It particularly helps to raise awareness of the role and management of technical information in catchment management. It also helps to identify the real difficulties most participants have in negotiations and clearly shows the need for capacity building in negotiating skills. The game never led to
a clear collective solution or a clear outcome to negotiations, except in the single case of the game played at the Alto Tietê Water Agency, where the players came up with the idea of creating a monetary fund. They had been debating for several months how to achieve cost recovery and proposed to introduce the fund to trigger negotiations. Every stakeholder in the game started with a financial stake. After the players had identified solutions to problems and agreed on priorities, the fund was allocated to different stakeholders by collective agreement.

These two parallel initiatives (the Agualoca game and the farmers’ workshops) led to a greater understanding of water quantity and quality issues, both within the sub-committee and amongst irrigators. We have not yet been able to implement a game gathering farmer representatives and other actors in order to promote a real dialogue between the different sectors involved in water management at catchment level. The development of capacity building activities on negotiation skills for sub-committee members would add value. This was planned but not implemented for lack of time.

Table 4.4 Summary of the Agualoca game

<table>
<thead>
<tr>
<th>Testing and validation session</th>
<th>Number of games played by Focus Group of the Sub-Committee of Cabeceiras-Tietê</th>
<th>Number of games played by SABESP Engineers</th>
<th>Members of the Water Agency of the Alto Tietê Water Basin Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game on its own</td>
<td>1</td>
<td>1</td>
<td>1</td>
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**Moving forward**

We assessed both the Ter’Aguas and Agualoca games with questionnaires, before the game (to assess player expectations) during it (to capture the dynamics of the game), and after (to verify the learning process and elicit suggestions). What did we learn from these evaluations?

Both games proved to be effective in mobilising discussions, but cannot be played without mediators or facilitators. The players cannot simply play on their own, but need at least one practice turn to understand the richness of all available elements (graphs, supporting material, etc). The players found both games interesting, very close to reality, sometimes enjoyable and effective for learning and capacity building in both technical and negotiation aspects.

Because knowledge is divided between players, it takes time for a real collective interaction process to begin. Alliances, negotiations and the formation of interest groups do emerge during the sessions. Discussions can be considered proactive even
if some conflicts appear in some simulations. Even with a good representation of real-life situations and good virtual reality in the game, it is difficult to capture all the complexities of peri-urban São Paulo, which derives from simultaneous dynamic interactions concerning water and land or quantity and quality issues. Depending on how the game is played, very different solutions can emerge. In some Ter’Agua sessions the social issues (illegal settlements, unemployment, etc.) were given more importance, while in others the emphasis was on access to public water and sanitation. It also became clear that holding preparatory workshops was a precondition for successful games, enabling the actors to understand that other forms of interaction were possible and even interesting.

A particularly interesting effect of this participatory modelling approach was that it enabled a collective learning process within the research group. The group brought together people from different backgrounds – academic researchers, those with expertise in supporting public sector decision-makers, specialists in action research with local actors or on local development. Unsurprisingly, each researcher assessed the potential and limitations of the methodology in light of their background. Some researchers tended to value the computer-based tools or exchanges of technical information, while others focused on the elaboration process or the sequence of interaction with the actors. Collective interactions allowed each scientist to verify their interpretation, derived from their research and pedagogical background, practices and experiences.

There is always a risk that the IT aspects of the game will remain a mysterious ‘black box’ for some players. Interestingly, this was much more of a problem within the Negowat team (as the computer implementation was the work of only two members, a modeller and an IT specialist) than for the players themselves. Local actors did not directly participate in elaborating the underlying models, so their knowledge was only indirectly incorporated into the model. A simplified version of this modelling was made with local actors in the Teraguas sequence, but it was not possible to confront the representation of the local actors with that of the institutional actors or researchers in the same meeting. Frankly, one wonders if this would have been possible at all given the difference of information and training between those groups, and whether the power relationships would even make it possible for local actors to express themselves fully in the same way as other participants.
Box 4.8 Some quotes from role-playing game participants

“At the beginning, I was rather confused. The situation is really difficult. We had a lot of things to do. I felt I was a very bad mayor. I felt I had no way out. We tried to solve the problems without a proper grasp on what was going on. We were legalising settlements without focusing on water issues. We realised our responsibilities were very great.”

(Community representative, in the role of Mayor, Ter’Aguas game, 26 August 2006)

“I had to revindicate things to the Municipality, they were refusing me a lot of things, landowners made also things rather difficult for us. It was very complicated, the situation is really bad.”

(Health agent, playing a community representative, about difficulties in getting improvements in the settlements, Ter’Aguas game, 26 August 2006)

“It was difficult because there always were obstacles. We were insisting that the municipality legalise our plots, because we needed water and there was always a problem. I played the role of intermediary between the Municipality and the landowner, and I managed to get something from the land owner… but nothing from the municipality…”

(Health agent playing a community representative, Ter’Aguas game, 26 August 2006)

“Man, I felt so important. If I really were with [SABESP], I could do anything! We put the water network in, the sanitation network. We did things according to the needs of the people, as required, we had no bias against anyone. We adapted our actions to the reality of the people. I think I convinced people, they are going to build a septic tank… Two more courses like this and I will be expert at it!”

(Community leader on her experience playing a water company manager, Ter’Aguas game, 26 August 2006.)

“Com a SABESP, no dia-a-dia, nós temos problemas, mandam a gente de um para outro…”

“With SABESP, on a daily basis, we have problems, they are always sending us to different people.”

(Municipal representative, playing the mayor, talking about real-life relations with SABESP)

“A sociedade civil deveria chegar mais organizada, com os interesses colocados de forma clara, com prioridades estabelecidas… as associações normalmente vem pedindo coisas particulares do bairro e não coisas comuns a vários bairros”.

“Civil society should arrive better organised, with their interests clearly stated, getting their priorities straight… Normally associations demand specific things for their settlement, not common improvements for various settlements”.
The Brazilian Negowat project tried to overcome the limits of ‘traditional’ environmental education processes and open up avenues that would change the mode of interaction between actors. It was of course too much to expect that such a change could occur in a short span of time, but a first evaluation of the methodology has indicated that it does contribute to change. It promotes individual learning and an understanding of the dynamics and interests, and widens the perspectives and potential for action on the part of different actors on various issues, including attitudes, relationships and possible solutions.

We carried through two complete Teraguas processes in the final four months of the project. It was not an easy process as participatory activities depended on our capacity to mobilise actors. We needed to have the support of the Municipality, as one of the objectives is to promote dialogue with the public sector. Moreover, it proved very difficult to mobilise specific sectors such as rural landowners (farmers, weekend home owners, absentee private landowners). We needed to develop specific sectoral activities, such as the workshops dedicated to agricultural issues and the environment to mobilise some farmers before we could initiate a more collective process in Cabeiceras Tietê Catchment. Had we applied such a dedicated approach to other sectors, it would probably have been easier to get them on board as well.

Most professionals in the Municipalities and public sector have little experience with participatory processes involving local stakeholders. The discrepancies between the game played with ‘real’ local actors and sub-committee representatives is probably illustrative of this gap. Their full involvement in a complete sequence of work is therefore difficult. A further problem was that local stakeholders were only available on Saturdays while institutional actors were not easy to mobilise on that day. As local organisations remained weak in this protected catchment area, identifying and mobilising representatives was also a problem. In many areas, there would be a need to build the capacity of local leadership and support the development of local organisations before engaging in a process like ours. The Teraguas process was not designed to mobilise the participation of local people for a specific collective action, but to increase the capacity of local representatives of slum dwellers and the public sector on new forms of more participative interaction about land and water issues. While Teraguas is a very apt method to prepare community leaders for negotiation on the implementation of new infrastructure or local plans, it is not very suitable for mobilising grassroot community members. Specific methodologies need to be developed when the basic means of community participation need to be stimulated.

The methodology clearly made a strong contribution to the mobilisation, mutual rapprochement and preparation of serious discussion or negotiation processes around the issues on the table. This type of activity can be particularly interesting when related to a specific development project (for example infrastructure). In existing multi-stakeholder platforms such as catchment committees, the
methodology could be a helpful way to introduce more complex simulation modelling and scenarios, using models validated and calibrated using the real life situation. After a simulation exercise based on a virtual and simplified exercise, some members from the Cabecceiras-Tietê catchment indeed asked for the organisation of discussions around an adapted simulation model more closely resembling the way the actual catchment functions. Many simulation models or geographic databases are justified by a desire to develop negotiation support tools. However, such tools rarely achieve their objective and are seldom effective in supporting multi-party discussions – either for lack of trust in the models or data, or because of a lack of understanding, because the scenarios do not really support collective work or because the approach is not well geared to mobilising non-specialists. Our methodology succeeded in introducing simulation to all parties, regardless of their level of awareness or capacity.

Other activities, such as training in negotiation skills, may become necessary. Even sub-committee members theoretically involved in negotiation processes had difficulties in performing well in a negotiation process. The original idea was to develop such training along with the AguAloca game, but unfortunately, we could not achieve this in the allocated time. Nevertheless, the project team has already been asked to integrate the tools into a formal training course on water management at catchment level. Some inputs will also be used in a web course about negotiation. It is also planned to integrate this into a in post-graduate course on environmental issues.

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