Hidrologia Política - uma nova abordagem

Political Hydrology - a new approach

DOI: 10.34188/bjaerv3n4-083

Recebimento dos originais: 20/08/2020
Aceitação para publicação: 20/09/2020

Ricardo Castro Nunes de Oliveira
Doutor em Engenharia Civil na área de Recursos Hídricos e Meio Ambiente /Universidade Federal do Rio de janeiro (UFRJ)
Instituição: Centro Brasileiro de Requalificação Fluvial
Endereço: Rua Dr. Nilo Peçanha 110/405, Ingá, Niterói, RJ, Brasil
E-mail: dradge@poli.ufrj.br

Rosiany Possati Campos
Doutora em Engenharia Civil na área de Meio Ambiente/Universidade Federal do Rio de Janeiro (UFRJ), Instituição: Centro Brasileiro de Requalificação Fluvial
Endereço: Rua Dr. Nilo Peçanha 110/405, Ingá, Niterói, RJ, Brasil
E-mail: rostiany.campos@poli.ufrj.br

Carlos Lima Castro
Advogado pela Universidade Santa Úrsula
Instituição: Centro Brasileiro de Requalificação Fluvial
Endereço: Rua Dr. Nilo Peçanha 110/405, Ingá, Niterói, RJ, Brasil
E-mail: carcastro@globo.com

RESUMO
O Brasil possui uma legislação robusta para preservação das bacias hidrográficas, especialmente para proteção das áreas ribeirinhas e das áreas de alagamento. No entanto, pode-se observar o aumento da degradação nas bacias hidrográficas que indica a fragilidade no esforço da preservação, que pode ser agravada pelas mudanças climáticas. O aumento da resiliência ambiental não será alcançado apenas com ferramentas de gestão, legislação, modelos matemáticos cada vez mais precisos ou por meio de uma espiral interminável de intervenções nos rios e suas margens. Para controlar o avanço da degradação, propomos um novo conceito - HIDROLOGIA POLÍTICA – que aborda novas questões, apropriando-se também de estudos antropológicos que explicam a crescente degradação de bacias hidrográficas e recursos hídricos. A observação antropológica participativa se faz necessária para orientar as decisões técnicas envolvendo muitos problemas que a engenharia busca quantificar e solucionar. Observa-se que as causas, os efeitos, os argumentos, os comportamentos sociais, a política e a economia estão interligados e influenciam e modificam as soluções de engenharia. Este novo conceito pode ser uma importante ferramenta para uma nova abordagem, combinando as técnicas e procedimentos da engenharia, sociologia, geografia e meio ambiente para a caracterização e preservação de bacias hidrográficas.

Palavras-chave: Hidrologia Política, Ecologia Política, Preservação de rios, Participação Social, Ética na Engenharia.
ABSTRACT
Brazil has strong legislation to preserve watersheds, especially to protect riverside areas and buffer zones. However, increasing degradation has been observed in some watersheds. This fact indicates the weakness of the preservation effort, which can be aggravated by climate change. Increased resilience will not be achieved only with increasingly accurate management tools, legislation, mathematical models, or through an endless spiral of interventions in rivers and their banks. To control the progress of degradation, we propose a new concept - POLITICAL HYDROLOGY - to address new issues, also appropriating anthropological studies that explain the increasing degradation of hydrographic basins and water resources. Participatory anthropological observation is a necessity to guide the technical decisions involving many problems that engineering seeks to quantify and resolve. It is important to observe how the causes, effects, arguments, social behaviors, politics, and economics are interlinked, influencing and modifying engineering solutions. This new concept can be an important tool for a new approach, combining the techniques and procedures of engineering, sociology and geography for the characterization and preservation of watersheds.

Keywords: Political Hydrology, Political Ecology, River Preservation, Social Participation, Engineering Ethics.

1 INTRODUCTION
The concept of Political Hydrology was presented for the first time at a conference on water resources in April 2015 in Cincinnati, USA. The introduction of this new approach in the examination of issues related to water resources was due to our involvement with water issues for decades, such as the use and supervision of water resources and social interaction with riparian inhabitants. We have acted as researchers, ecologists and inspectors in the use and occupation of areas that belong to the Brazilian government in recent years. In this work, we highlight the degradation of federal rivers1. Our experience reveals a sense of defeat in the struggle to preserve Brazilian rivers for the current and future generations. The latest alerts of the Intergovernmental Panel on Climate Change (IPCC) indicate that the world should rethink the current model of use, management and monitoring of water resources.

The text highlights the urgency that an anthropological view in the technical decisions of many problems that engineering quantifies and proposes to solve. Engineers, in particular, should rethink the current model of the use, management and monitoring of water resources. The causes, effects, arguments, social behaviors, politics, and economics are intertwined, influencing and modifying engineering solutions.

Some river basins in the Southeast region of Brazil are particularly subject to growing degradation. This is a terrible reality, one that can worsen in coming years with climate change, the disorganized growth of urbanization and conurbation processes. This framework reveals a major

1 Lakes, rivers, and streams present in any land belonging to the Federal domain, or that bathe more than one State, serve as boundaries with other countries, extend to the foreign territory or originate from foreign territories, as well as the riparian lands, in federal rivers, and the river beaches.
weakness in river preservation efforts. In addition, recent disasters like the breach of the tailings dam of Samarco in the municipality of Mariana in 2015 (see Espindola et al., 2019) and also of the tailings dam of Vale in Brumadinho in 2019, both in Minas Gerais State, reinforce this perception and show the lack of current efforts for river preservation and how the lives of riparian inhabitants can be severely affected.

According to Porto (2016), it is important to see disasters from a broad perspective with a critical socioenvironmental focus. Thus, solutions to control this degradation cannot be pursued only with the current legislation, engineering tools, more precise mathematical models and countless works and interventions in rivers and their banks. Nowadays, it a more comprehensive approach is necessary, one that can also consider the social and anthropological aspects, ethics, fairness, and justice involved in the process of river degradation. It is necessary to reinforce engineering codes of ethics considering public safety, health and welfare (Brauer, 2013).

The surveillance of rivers in Brazil helps to understand that the continuation of current policies will be unable to ensure the preservation of rivers for future generations. It is also true that the engineers responsible for works that have been performed in rivers and their banks often do not have a real understanding of the social and environmental impact of these works. The supervision, legislation and engineering procedures are not sufficient to ensure water availability. It us urgent to develop a technical agenda to take an anthropological view of the many problems that engineering quantifies and presents propositions. Besides this, the causes, effects, arguments, social behavior, politics, and economics are intertwined and influence and change engineering solutions.

One of the classic questions of social theory is to understand that behavior and institutions are affected by social relations (Granovetter, 1985); that resilience is the ability of society (individuals, groups, communities) to cope with change, including shocks to their social infrastructure and the complexity of social-ecological systems (Finkbeiner et al., 2017; Kittinger et al., 2012; Adger, 2000), and that linkages between stakeholders in resource management produces winners and losers (Adger et al., 2005).

Another aggravating factor of the degradation problem is that many researchers who develop proposal and projects involving rivers seldom have real contact with them and with the local population. Traditional scientific grants rarely include components for consulting with local groups, so such contacts carried out as part of research projects must usually be “bootlegged.” (Wohl et al., 2005). Once again, the failures the tailings dams serve as good examples. Those responsible for the construction and maintenance of those dams did not fully observe the risks that the dams could pose to riverside populations.
Another aspect that must be considered is the weak commitment of governments, companies and even engineers to listen to the people and collaboratively discuss the positive and negative aspects and the risks associated with interventions in rivers. The truth that still prevails in academe, construction companies and the public administration is a feeling of supreme knowledge, making their projects beyond challenge. Of course, for many it is more economical and comfortable to conduct design of studies based mainly on satellite images and topographic maps, without expensive travel and boring meetings with the local population. Of course, it is more pleasant to work in air conditioned offices than in the countryside, and to avoid the nuisance of possible criticism and knowledge of local people.

Over the years, projects are being developed in big cities increasingly distant from the site of their implementation. Of course, this distance and the lack of integration with the people who will be affected by the project are points of weakness for the preservation of river space. Rivers are under pressure and need more integration and cooperation in planning, management and development of new synergies (e.g., Evers and Nyberg, 2013). The inclusion of diverse stakeholders’ viewpoints and value-sets in policymaking is therefore imperative (Workman et al., 2020). However, Verwoerd et al. (2020) pointed out that in transdisciplinary research (TDR), it is necessary to pay heed to four key aspects: participation by relevant stakeholders; knowledge integration for change; responsive and emergent design; and effective boundary management.

As an aid to preservation and based on the Political Ecology, this paper suggests a new sub-area, more appropriate to the field of engineering and water resources – Political Hydrology. This involves considering new questions and new reflections by engineers. Issues such as “the real participation of the riparian inhabitants in management of basins”, “the effects of the implementation of river projects,” and “how political decisions can affect engineering projects”, need to be addressed. According to Priemus (2010), often, unforeseen outcomes are triggered by political discontinuity and market dynamics.

It is also necessary to appropriate anthropological studies that shed light on the growing degradation of watersheds and water resources. Engineers have to play a more prominent role in smart growth and sustainable development, to safeguard public resources for a bright future (Wang, 2002).

The objective is that this work will launch discussion of the topic in engineering schools and among environmentalists, providing favorable conditions to reverse the current situation of degradation of water resources, in particular the important federal rivers in Brazil.
2 POLITICAL HYDROLOGY

Defining the best way to implement social participation and gain an understanding about personal ethics, fairness and justice is not an easy task (see, e.g., Singer, 2011; Mc Kerlie, 2001; Bostock, 2000). It is very difficult to give universal definitions and usage of these terms in different countries or cultures. As stated by Foldvary (1980), while universal ethics is independent of personal or cultural views, personal or cultural ethics can change over time, as sexual ethics have been changing in this century. Surely, in a continental country such as Brazil, the different types of people, cultures, levels of education and environmental realities can increase differences in feelings about personal ethics.

In the current century, these aspects cannot be relegated to the public managers and engineers involved with the preservation and use of water resources. A new way to manage basins and implement hydraulic works is needed, based on an association between engineering techniques and a new philosophical approach that can see the interactions among the environment, water uses and rights of riparian inhabitants as a whole.

However, other aspects need accurate observation when speaking about ethics and justice in the use of water resources in Brazil. It is necessary to pay close attention to the involvement of the local population in the decision-making process. Usually decisions are made based largely on discussions among public managers and few technicians, without any concern for the opinions of local stakeholders. According to Tippett et al. (2005), failure to ensure adequate representation of stakeholders, or to attract a broad range of stakeholders and key players, can lead to decisions that lack legitimacy.

This traditional practice of developing projects and building hydraulic works in Brazil is a big mistake. On the other hand, it is possible to work with more justice, fairness and ethics. It is possible for engineers, hydrologists and public managers to look with more concern at environmental preservation and the relationship between projects and social impacts. The principles and process of development and of Political Ecology can serve as support to the process of Political Hydrology. To achieve successful adaptation strategies, knowledge obtained through integration and cooperation of actors from various disciplines, sectors and hierarchical levels is necessary (Donaghy, 2007, as cited in Albert et al., 2012).

There is a consensus that the term “political ecology” first emerged in 1935 in an article by Frank Thone entitled "Nature Ramblings: We Fight for Grass", Thone (1935). Since then, the meaning of this term has changed and increased in importance in different academic areas. These changes became more significant in the 1960s due to the emerging recognition of environmental crisis, prompting researchers, anthropologists, philosophers, and more recently geographers, in
different countries to discuss the meaning of political ecology and how this field can help to improve human-environmental interactions.

‘Ecology’ was originally seen as the study of these impacts, but also as a new philosophical approach to human-environmental interactions as a whole. This thought was well represented in an article by Aldous Huxley - "The ecology of politics: the question of survival, Huxley (1963).

However, according to Forsyth (2003), it was only in the late 1960s and 1970s that the first academic works (see Russett, 1967; Wolf, 1972; Miller, 1978; Cockburn and Ridgeway, 1979) were published. Other studies at that time can be mentioned, such as Enzensberger (1974). A similar interpretation was given by Walker (2005). The first use of the term political ecology is often traced to Wolf (1972). A book published in 1985 called The Political Economy of Soil Erosion in Developing Countries by Piers Blaikie, Blaikie (1985), brought an innovative study of environmental and erosion problems in developing countries and addressed the need for social change and political judgments.

In 1987, an interesting definition of political ecology appeared and it has been accepted as valid until today. It includes some aspects to be considered in the field of Political Hydrology. According to Blaikie and Brookfield (1987), “The phrase ‘Political Ecology’ combines the concerns of ecology and a broadly defined political economy.” Together, these subjects encompass the constantly shifting dialogue between society and land-based resources, and also within society itself. It is important to highlight that when talking about rivers, the surrounding land can be understood as the watershed.

Thus, the first studies in which environmental problems were analyzed and understood more than just in the economic and political context in which they were created, included anthropological observations. In this new line, when environmental problems are studied, consideration is given to the intertwined political and economic aspects. As stated by Harvey (1993), all ecological projects (and arguments) are at the same time political and economic projects (and arguments) and vice versa.

Research reveals that this concept echoed in Brazil in the 1960s. That decade saw the embryonic formation of an ecological political perception that began to manifest itself indirectly in the area of water resources in the ensuing years. Actually, the seed of the management of water resources can be traced to back to 1934, with the issuance of Decree 24,643, called the "Water Code". In 1965, Law 4,771 ("Forest Code") was enacted, and subsequently replaced in 2012 by Law 12,651. The Forest Code clearly defined for the first time the limits of preserved areas along rivers, around springs and on mountain tops. Another important mark of ecological political perception was the participation of Brazil in the United Nations Conference on Water - Mar del Plata 1977. More recently, the need for environmental preservation was enshrined with promulgation of the 1988 Constitution. According to Little (2006): “Some of the most important recent transformations in the
ecological paradigm are the development of transdisciplinary syntheses between the social and natural sciences.” This statement is in line with the growing importance of political ecology for geography.

According to Nygren and Rikoon (2008), political ecologists are interested in exploring how control and access to natural resources are defined and contested in various political arenas, while according Turner and Robbins (2008), land-change science (LCS) and political ecology (PE) have emerged as two complementary but parallel approaches to address human environment dynamics for sustainability.

Thus, the study and the implementation of interventions in the fluvial space cannot be developed without considering the analysis of environmental problems in the social, economic and political context in which they occur. An integrated observation is necessary. An anthropological observation is necessary to decrease the risk repeating past old mistakes. All hydraulic works and projects as well as their arguments for implementation are at the same time social, environmental, political and economic actions and arguments. Thus, a holistic view is a basic requirement for interventions in watersheds.

The American historian Donald Worster (2013) warned about the depletion of natural resources, recommending the use of scientific and technological knowledge as a tool for building a culture compatible with the environment. Here we highlight the importance of Political Hydrology as a new approach that can contribute to the construction of this new culture and strengthen the universal right to water. It can be an important tool to provide more justice, ethics and equitable solutions to the use of water and other environmental resources.

3 THE HEALTH OF THE WATERSHED AND POLITICAL HYDROLOGY

Themes such as actions that restore rivers and springs, protect the original vegetation of hydrographic basins, and make cities more resilient to the challenges of climate change have been extensively studied, but few effective results have been achieved. Some examples can be cited. According to the FAO (2013), although uncertainty exists about the magnitude and timing of the impacts of climate change on forest ecosystems, sufficient scientific information is available to begin taking action now. In Brazil, the current watershed management model has weaknesses and needs improvement (ANA, 2017; Heller, 2014; Brannstrom et al., 2004; Veiga and Magrini, 2013). According to Bernhardt et al. (2007), despite expenditures of more than 1 billion dollars annually, there is little information available about project motivations, actions and results for the vast majority of river restoration efforts in United States.
These failures in delivering consistent results contradict the news in the media around the world on weather events and problems arising from fires, floods, landslides, water shortages, and others. There are gaps variously between news, researchers, the public and politicians. The problem is not the lack of knowledge of the main causes and effects, but the lack of priority and evaluation that is given to these issues in the daily lives of people and decision-makers. There is a lack of real involvement of society in problems, so that environmental issues are treated as fundamental parts of their lives, equal to family, work, health and even the passion that many have for their sports teams.

In Brazil, this lack of priority in addressing environmental issues is observed closely by us. Experiences in private and public works such as roads, dams, dredging and irrigation, supervision, and control of Brazilian rivers highlight that the country’s water resources are facing increasing degradation. Even with numerous laws and public entities, including Basin Committees, the degradation is not controlled

This allows us to affirm that there are a large number of technicians who have little or no concern for questions of the environmental, ethical and social aspects involved in their actions. We have noted this in our work together with federal prosecutors. Last but not least, it is necessary to talk about a sensitive point: the aversion of many researchers, professors and instructors in engineering schools to tackle their projects in a frank, open and respectful manner with local stakeholders.

Thus, it is necessary for all stakeholders to be equal parties pursuing the same objective in a watershed with a new approach. All parties must have the same importance and their voices must be heard with egalitarian power of decision in planning of projects and use of water. Also, stakeholders must not forget that climate change means that environmental preservation is an obligation of all. Political hydrology is a new coding presented here. It is a tool to implement this new approach and reinforce watershed preservation. The construction of a proposal for a new sub-area of political ecology with the creation of Political Hydrology can provide a powerful tool to address environmental problems and their consequences. This could induce the introduction of water resources in the priority agenda of politicians, engineers and citizens. New questions need to be formulated, appropriating also anthropological studies to help avoid the increasing degradation of watersheds and water resources. Questions about environmental protection, ethics, justice, social participation, and fairness should be more relevant in the engineering area.

Next, the study presents the SWOT matrix (Strengths, Weaknesses, Opportunities, Threats) as a support tool to form an understanding of how the use of Political Hydrology can act in the preservation of watersheds. Some researchers trace the creation of the SWOT matrix to studies developed by Learned et al. (1965), while others mention studies developed by Albert Humphrey, who led a research project at Stanford University in the 1960s and 1970s. Since then, SWOT analysis
has developed and has been used in various fields (Chermack and Kasshanna, 2007; Gao et al., 2017). It allows distinguishing the internal environment (internal factors and realities - strengths and weaknesses) and the external environment (future factors and aspects - opportunities and threats) of the analyzed system, which in the case here is the watershed. This tool allows a clear and objective assessment of how Political Hydrology can improve the management of water resources and the preservation of the hydrographic basins. The implementation of Political Hydrology can help reinforce the strengths and opportunities and minimize the weaknesses and threats that we have observed in river basins in Brazil (Table 1).

Table 1. SWOT Matrix

| STRENGTHS                                                                 | WEAKNESSES                                                                 |
|--------------------------------------------------------------------------|---------------------------------------------------------------------------|
| . Inhabitants’ desire to preserve watersheds;                           | . Lack of integration of researchers and inhabitants;                      |
| . Existence of good environmental laws requiring permanent preservation  | . Inability of the media and researchers to correctly present climate      |
| areas along rivers, on hilltops and surrounding springs;                | problems to the inhabitants of basins;                                    |
| . Existence of are Basin Committees;                                     | . Little concern with ethics and justice in the execution of hydraulic     |
| . Existence of are fees for water use to promote more efficient use;     | works;                                                                    |
| . Existence of vast academic knowledge about the problems of water       | . Lack of involvement of technical schools and universities in discussing  |
| resources and basin management in Brazil.                                | projects and facing challenges;                                           |
|                                                                         | . Lack of discussion about the resilience of cities in the face of climate |
|                                                                         | changes;                                                                  |
|                                                                         | . Absence of issues, such as basic sanitation, water reuse and increased  |
|                                                                         | soil permeability in urban areas;                                         |

| OPORTUNITIES                                                                 | THREATS                                                                 |
|----------------------------------------------------------------------------|------------------------------------------------------------------------|
| . Creation of participatory projects without political discontinuity;      | . Lack of commitment by federal, state and municipal governments in     |
| . Integration in the different spheres of government of the information    | participatory projects;                                                |
| about project areas;                                                      | . Insufficient financial support;                                       |
| . Construction of a culture compatible with environmental preservation;    | . Weak interaction with the media;                                      |
| . Inclusion in traditional scientific grants of components for consulting | . Short-term plans stemming from transitional public policies;          |
| local groups;                                                             | . Little commitment of engineers to environmental protection, with      |
| . Identification of different actors;                                     | insufficient attention to smart growth and sustainable development.     |
| . Search for solutions with stakeholders;                                 |                                                                         |
| . Articulation of different policies (socio-environmental, heritage,      |                                                                         |
| economic and urban);                                                     |                                                                         |
| . Identification of monetary benefits (payment for environmental services);|                                                                         |
| . Reinforcement of communication among media, researchers, politicians    |                                                                         |
| and inhabitants;                                                         |                                                                         |
| . Sharing of academic knowledge with inhabitants;                         |                                                                         |
| . Interaction of the media, local society, scientists and public entities;|                                                                         |
| . Encouragement of spatial planning;                                      |                                                                         |
| . Development of projects in a more adaptive way with environmental       |                                                                         |
| protection.                                                               |                                                                         |
Thus, Political Hydrology can act as a tool that enables engineers to take a more holistic and multifaceted view. This allows decision-making to move from an isolated and fragile position that is based on an understanding of the superiority of the technical position to a better position that associates technical aspects with social, cultural and political issues. Strengths such as inhabitants’ desire to preserve watersheds can be better understood and reformed. Weaknesses such as lack of integration with researchers and inhabitants can be overcome. The SWOT matrix shows there is an opportunity to implement Political Hydrology and build a culture compatible with the environment. This would allow significant advances in many of today's cultural facets. For example, it would allow changing the current culture in which channeled rivers are considered to be simple drainage and sewage channels.

According to Oliveira (Oliveira et al. 2013; Oliveira 2011), these rivers do not exist politically. They are considered objects of little value, both the intrinsic value of their physical areas, as well as their gutters, margins, floodplains and recharge areas in formation. The issues presented in the SWOT matrix would be better understood through Political Hydrology with additional studies on social and anthropological behavior. This could prevent the increasing degradation of hydrographic basins and water resources. More discussion and knowledge are needed on the relationship between increasing urbanization and cultural changes in a population that in recent decades was largely rural. The lack of integration between rivers and the city dwellers prevents them from understanding that the rivers channeled and hidden in the galleries under the buildings and avenues were the same rivers that previously were inherent to the beauty of the country.

4 ETHICS, SOCIAL JUSTICE AND POLITICAL HYDROLOGY

Rivers are like human arteries, and without them, life as we know it would be altered. Is water the blood in this analogy, so it can be properly valued, or has it been transformed into merchandise? What ethics should be pursued or social justice achieved in the availability of water when engineers and managers develop studies in a watershed or execute development plans? What ethics are involved when we brush our teeth with the tap running? What ethics are involved when we use water to sweep sidewalks? What ethics are involved when hydroelectric plants are approved without thoroughly considering the impact on the continuity of the river, on the fish population, and traditional riverside communities? Why can profound changes in river regimes be generated for the generation of energy and/or water supply that will benefit large urban centers outside the affected watershed, with a clear detriment to the interests of local populations? What ethics are involved in the recent tailings dam disasters in Brazil, which caused irreparable human and environmental damages? What ethics are involved in the recent crisis of the water supply in the city of Rio de Janeiro, where contamination of
the distributed water forced the population to buy “mineral water” to drink and prepare food? Each of these questions can have opposite points of view, conflicting interests, and ethical nuances, but ethics in each of these cases deserves to be discussed concretely and must be a guiding principle for engineers, a fact that, unfortunately, currently does not occur.

It is necessary to understand the risks of occupying areas such as of floodplains and slopes and their adaptation by different social groups, such as inhabitants of riparian areas. It is also necessary to understand which ecological cultural changes have occurred and how they cause difficulty of prioritizing public policies committed to the preservation of water resources. The lack of social justice and ethics in the management of public goods has led to the establishment of many slums in high-risk areas on slopes or riverbanks, and of upscale residential and hotel projects along the coastline, including in mangroves and bays.

In this last respect, property of the Brazilian government with great economic value, such as along Copacabana Beach (“navy land”) or in Alphaville, a gated community in the city of São Paulo, are occupied by wealthy people without any reservation of areas for the poor population. Now when the effects of climate changes are threatening water resources, the poor inhabitants in riparian areas and in risky slum areas are more affected, and disasters involving poor people have increased the degradation of basins. In the end, the degradation of rivers affects all people. In Brazil there is a popular saying related to this situation in which the causes and effects interact among themselves, it is “the dog chasing its tail”.

In this sense, engineers can no longer neglect ethical and social issues. It is important to understand the limits and weaknesses of Keynesian approaches and the "polluter pays principle", which turn water into a commodity, as well as the limitations of Marxist concepts in the analysis of the preservation of water resources. The truth is that the discussion and the search for answers that can support the preservation of water resources are not utopian. The possibility of reaching this understanding can be seen in Little (2006), who stated that anthropology can help in the analysis of ecological adaptation and how conflicts affect different social groups.

Political Hydrology can increase the accuracy in a sense of more justice and ethics when combining the techniques and procedures of engineering, geography and anthropology for

---

2 The shoreline strip of 33 meters inland from the maximum tide in 1831 is classified as federal land (Fries et al., 2019). More generally, the federal government has domínio direto or domínio pleno (direct domain or full domain) over certain plots of land and may grant domínio útil (useful domain) to people or companies, known as foreiros or enfiteutas, against payment of foro (annual ground rent or fee), under an arrangement called aforamento. These parties are allowed to sell their rights to other parties, provided a transfer fee called laudêmio (laudemium) is duly paid, or to lease or otherwise assign those rights. This situation derives from the idea of emphyteusis, a type of perpetual tenure under Roman law. It is generally the case for land along the coastline (known as “navy land”, terrenos de marinha) and the land along federal rivers (known as “bank land”, terrenos marginais). Such federal land can also be occupied by private parties, in return for payment of a yearly occupation fee.
characterization of watersheds and their rivers. Anthropology can discuss the perception of the Brazilian people about their tropical exuberance and bountiful rivers. Since the time of discovery of Brazil, these thoughts have remained in the national subconscious, causing political passivity to preserve resources that are of common use. Similarly, the Canadian author and activist Maude Barlow (2013) described the problem of water in the United States and Canada in the coming years and highlighted: “Brazilians and Canadians grew up with the myth of abundance. They believed that water is so plentiful that it will never end. This is simply false.” The facts in recent years show that Brazilians are facing new surprises with the rainfall regimes. The repetitive story that the scarcity of water is a specific problem of the Northeast region is not true anymore. Even the Amazon region has faced years of water scarcity in many rivers. More discussion and knowledge are needed about the relationship between increasing urbanization and the cultural attitudes of a population that was in the past decades largely rural.

With the rapid growth of the population and consequent disorganized occupation of cities, the expansion of agriculture, the increasing energy needs and the diversion of water for human consumption, profound changes have been made in the geomorphology and land use in river basins. These changes show that the use of water resources is facing limits, generating increasing conflicts. Thus, managing the use of water resources and balancing demand and supply have been a major challenge, among many others. Challenges exist for preservation of water bodies, flood control in urban areas, erosion control in hydrographic basins, and implementation of effective water treatment and supply stations, among others.

Brazilian territory is mostly characterized by intense summer rains. These rains together with the degradation of hydrographic basins and uncontrolled urbanization increase economic loss and loss of life. The disorderly growth of cities has changed the natural environment, caused the suppression of natural areas, dramatically changed the natural cycle and caused more intense flooding. Human activities affect infiltration and increase the surface runoff, thus causing the concentration of water in a short time in the low-lying areas. Human activities also promote the degradation and modification of the operation of river systems. Often these changes can cause such a loss of natural functions that the restoration of an ecosystem is unattainable.

Understanding these growing changes (in many cases despite the existence of laws and regulations), is difficult because of the interrelations that caused these changes, whether they are technical or social. Little (2006) mentioned that for there to be a truly ecological science, a deep dialogue is needed between the social sciences and natural sciences, with focus on the dynamic and interdependent relationship between the biophysical world and the social world.
In a study of Australian rivers, Brierley and Fryirs (2005) mentioned changes in natural conditions resulting in a significant loss of river health. The natural condition is defined as the ability of a river and its ecosystem to perform their natural functions. The health of a river can be evaluated by the conditions of its watershed to promote environmental and social health. Thus, it is evident that the preservation of rivers is not achieved only through engineering techniques.

The uncontrolled exploitation of watersheds, lack of protection of marginal areas and lack of demarcation of permanent preservation areas are important river degradation factors. These factors are reflected in floods, spread of contaminated water, worsening of diseases, shortage of drinking water, ecosystem degradation and erosion. The ecological health of rivers exceeds the riverside flora and fauna, also affecting water use and the morphological balance. Moreover, the preservation of basins minimizes hydraulic risks.

Political Hydrology can be a tool that allows understanding the complexity of the problems related to the preservation of water resources and the different aspects that can be involved in interventions. These aspects are ethical, cultural, economic and environmental. Political Hydrology can help to understand how economic externalities alter access to water resources in a basin and how they can internalize new economic and environmental problems. Political Hydrology can contribute to the understanding of how natural river processes alter the balance between the liquid and the solid phase in a river and how these changes are affected by human interventions and political decisions. Also, Political Hydrology can find answers to ensure less impact on demands and needs outside the watersheds, helping the local populations to preserve the environment. Therefore, Political Hydrology is an essential tool to preserve watersheds.

5 CONCLUSIONS

The implementation of a more holistic vision, together with the tools of Political Hydrology, can represent a major advance in the understanding of how social, economic and political issues interact with the environment, causing significant impacts on the watershed and the health of rivers. The real perception of problems for the conservation of hydrographic basins and their causes can contribute to better and more adequate public policies, also involving new actors.

It is necessary to identify the anthropological causes that inhibit the implementation of actions more concerned with ethical and justice parameters. In this sense, it is necessary to understand the reasons why some engineers show little concern for the impacts of hydraulic works and risk analysis of riverside populations.

In this line, the application of Political Hydrology is essential for the defense of public areas along rivers and the effective use of public resources. Political Hydrology is a tool to support projects
related to river restoration. It is fundamental for the integration between rivers and the local inhabitants and the preservation of these rivers and their hydrographic basins.

REFERENCES

Adger, W. N., Brown K. and Tompkins, E. L., 2005. The political economy of cross-scale networks in resource co-management. Ecology and Society 10(2): 9. DOI: 10.5751/ES-01465-100209.

Adger, W.N., 2000. Social and ecological resilience: are they related? Progress in Human Geography 24, 347–364.

Alexandra S. Fries, João P. Coimbra, David A. Nemazie, Robert M. Summers, José Paulo S. Azevedo, Solange Filoso, Marlus Newton, Guido Gelli, Ricardo Castro Nunes de Oliveira, Marco Antonio R. Pessoa, William C. Dennison, 2019. Guanabara Bay ecosystem health report card: Science, management, and governance implications. Regional Studies in Marine Science, Volume 25, 2019, 100474, https://doi.org/10.1016/j.rsma.2018.100474.

ANA, 2017. Conjuntura dos recursos hídricos no Brasil 2017: relatório pleno , Agência Nacional de Águas, Brasília, 2017. http://www.snirh.gov.br/portal/snirh/centrais-de-conteudos/conjuntura-dos-recursos-hidricos/relatorio-conjuntura-2017.pdf

Barlow. M., 2013. Jornal O GLOBO, entrevista Revista Amanhã.

Bernhardt, E.S., Sudduth, E.B., Palmer, M.A., Allan, J.D., Meyer, J.L., Alexander, G., Follastad-Shah, J., Hasset, B., Jenkinson, R., Lave, R., Rumps, J. and Pagano, L., 2007. Restoring Rivers One Reach at a Time: Results from a Survey of U.S. River Restoration Practitioners. Restoration Ecology, 15: 482-493. doi:10.1111/j.1526-100X.2007.00244.x

Blaikie, P., 1985. The Political Economy of Soil Erosion in Developing Countries. London: Routledge, https://doi.org/10.4324/9781315637556

Blaikie, P.M. and Brookfield, H., 1987. Land degradation and society. London and New York: Methuen. ISBN-10: 1138923079.

Bostock, David, 2000. Aristotle's Ethics. Oxford University Press.

Brannstrom, C. et al., 2004. Civil society participation in the decentralisation of Brazil’s water resources : assessing participation in three states. Singapore Journal of Tropical Geography, v. 25, n. 3, p. 304–321, 2004. https://doi.org/10.1111/j.0129-7619.2004.00188.x.

Brauer, C., 2013. Just Sustainability? Sustainability and Social Justice in Professional Codes of Ethics for Engineers. Science & Engineering Ethics, 19(3), 875–891. https://doi-org.ez29.capes.proxy.ufrj.br/10.1007/s11948-012-9421-4

Brierley, G.J., Fryirs, K.A., 2005. Geomorphology and River Management – Applications of the River Styles Framework.
Christian Albert, Thomas Zimmermann, Jörg Knieling, Christina von Haaren., 2012. Social learning can benefit decision-making in landscape planning: Gartow case study on climate change adaptation, Elbe valley biosphere reserve, Landscape and Urban Planning, Volume 105, Issue 4, 2012, Pages 347-360, ISSN 0169-2046, https://doi.org/10.1016/j.landurbplan.2011.12.024.

Cockburn, A., Ridgeway, J., 1979. Political Ecology: an Activist’s Reader on Energy, Land, Food, Technology, Health, and the Economics and Politics of Social Change, New York: Times Books.

Dennis, Mckerlie, 2001. Aristotle's Ethics. David Bostock, Mind, Volume 110, Issue 440, October 2001, Pages 1046–1050, https://doi.org/10.1093/mind/110.440.1046.

Donaghy, K., 2007. Climate change and planning: Responding to the challenge. Town Planning Review, 78(4), i–xi.

Enzensberger, H.M., 1974. “A critique of political ecology”, New left review, 84(3-31).

Espindola, Haruf Salmen, Nodari, Eunice Sueli, & Santos, Mauro Augusto dos., 2019. Rio Doce: Risks and Uncertainties of the Mariana Disaster (MG). Revista Brasileira de História, 39(81), 141-162. Epub July 29, 2019. https://dx.doi.org/10.1590/1806-93472019v39n81-072

Evers, M. and Nyberg, L., 2013. Coherence and inconsistency of European instruments for integrated river basin management, International Journal of River Basin Management, 11:2, 139-152, DOI: 10.1080/15715124.2013.811416.

FAO, 2013. Climate change guidelines for forest managers. FAO Forestry Paper No. 172. Rome, Food and Agriculture Organization of the United Nations.

Finkbeiner, E.M., Oleson, K.L., Kittinger, J.N., 2017. Social Resilience in the Anthropocene Ocean. In Conservation for the Anthropocene Ocean; Academic Press: Cambridge, MA, USA, 2017; pp. 89–106.

Forsyth, T., 2003. Critical political ecology: the politics of environmental science. London: Routledge. ISBN 0-203-01756-0 Master e-book ISBN.

Fred, E. Foldvary, 1980. The Soul of Liberty: The Universal Ethic of Freedom and Human Rights. Gutenberg Press, Political Science, 325 pages. ISBN-13: 978-0960387212.

Granovetter, M., 1985. Economic Action and Social Structure: The Problem of Embeddedness. American Journal of Sociology, 91(3), 481-510. Retrieved February 11, 2020, from www.jstor.org/stable/2780199

Harvey, D., 1993. The nature of environment: dialectics of social and environmental change.

Heller, Léo, 2014. Explaining successes and failures of river Basin committees in Brazil. Brazilian Political Science Review, 8(1), 131-137. Avaliable from http://dx.doi.org/10.1590/1981-38212014000100007.

Huxley, A., 1963. The Politics of Ecology: The Question of Survival. Center for the Study of Democratic Institutions.

Kittinger, J. N., E. M. Finkbeiner, E. W. Glazier, and L. B. Crowder, 2012. Human dimensions of coral reef social-ecological systems. Ecology and Society 17(4): 17. http://dx.doi.org/10.5751/ES-05115-170417.
Learned, A., Christensen, C., Andrews, R. S. and Guth, D., 1965. Business Policy: Text and Cases (Homewood, Illinois: Irwin).

Little, P.E., 2006. Ecologia Política como Etnografia: Um Guia Teórico e Metodológico. Horizontes Antropológicos, Porto Alegre, ano 12, n. 25, p. 85-103, jan/jun. 2006.

Mark Workman, Kate Dooley, Guy Lomax, James Maltby, Geoff Darch, 2020. Decision making in contexts of deep uncertainty - An alternative approach for long-term climate policy, Environmental Science & Policy, Volume 103, 2020, Pages 77-84, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2019.10.002.

Miller, A., 1978. A planet to Choose: Value Studies in Political Ecology, New York: Pilgrim Press.

Nygren, A., Rikoon, S., 2008. Political Ecology Revisited: Integration of Politics and Ecology Does Matter, Society and Natural Resources, 21:9, 767-782, DOI: 10.1080/08941920801961057. https://doi.org/10.1080/08941920801961057.

Oliveira, R.C.N. et al., 2013. Comitê da Bacia do Rio Macaé - Desafios para uma gestão participativa da sociedade local. ABRH, XX Simpósio Brasileiro de Recursos Hídricos, Bento Gonçalves-RS.

Oliveira, R.C.N., 2011. Caracterização das Áreas de Domínio da União e das Faixas Marginais de Proteção apoiada por Modelação Matemática – Estudo de Caso: Médio Rio Paraíba do Sul. Dissertação de Mestrado - POLI/UFRJ, RJ. http://www.dissertacoes.poli.ufrj.br/dissertacoes/dissertpoli456.pdf

Porto, Marcelo Firpo de Souza, 2016. A tragédia da mineração e do desenvolvimento no Brasil: desafios para a saúde coletiva. Cadernos de Saúde Pública 2016, v. 32, n. 2: <https://doi.org/10.1590/0102-311X00211015>. Epub 11 Mar 2016. ISSN 1678-4464. https://doi.org/10.1590/0102-311X00211015.

Priemus H., 2010. Decision-making on Mega-projects: Drifting on Political Discontinuity and Market Dynamics. European Journal of Transport and Infrastructure Research, 01 March 2010, Vol.10(1)

Russett, B. (1967) International Regions and the International System: a Study in Political Ecology. Chicago, IL: Rand McNally.

Singer, P., 2011. Practical Ethics. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511975950.

Thomas J. Chermack, Bernadette K. Kasshanna, 2007. The Use and Misuse of SWOT Analysis and Implications for HRD Professionals, Human Resource Development International, 10:4, 383-399, DOI: 10.1080/13678860701718760.

Thone, F., 1935. Nature rambling: We fight for grass. The Science Newsletter, v. 27, n. 717, p. 5-14, Jan.

Tippett, B. Searle, C. Pahl-Wostl, Y. Rees., 2005. Social learning in public participation in river basin management—early findings from HarmoniCOP European case studies, Environmental Science & Policy, Volume 8, Issue 3, 2005, Pages 287-299, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2005.03.003.
Turner, B., Robbins, P. (2008). Land-change science and political ecology: Similarities, differences, and implications for sustainability science. Annual Review of Environment and Resources, 33, 295-316. https://doi.org/10.1146/annurev.environ.33.022207.104943

Veiga, L.B.E., Magrini, A., 2013. The Brazilian Water Resources Management Policy: Fifteen Years of Success and Challenges. Water Resources Management, v. 27, n. 7, p. 2287–2302. https://doi.org/10.1007/s11269-013-0288-1

Verwoerd, P., Klaassen, S.C. van Veen, R. De Wildt-Liesveld, B.J. Regeer, 2020. Combining the roles of evaluator and facilitator: Assessing societal impacts of transdisciplinary research while building capacities to improve its quality, Environmental Science & Policy. Volume 103, 2020, Pages 32-40, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2019.10.011.

Walker, P.A., 2005. Political ecology: where is the ecology? Progress in Human Geography 29, 1 (2005) pp. 73–82

Wohl, E., Angermeier, P. L., Bledsoe, B., Kondolf, G. M., MacDonnell, L., Merritt, D. M., Palmer, M. A., Poff, N. L., and Tarboton, D., 2005. River restoration, Water Resour. Res., 41, W10301, doi:10.1029/2005WR003985.

Wolf, E., 1972. Ownership and political ecology. Anthropological Quarterly 45, 201–05.

Worster, D., 1993. The wealth of nature: environmental history and the ecological imagination. New York: Oxford University Press.

Worster, D., 2013. From an Age of Abundance to Age of Vulnerability. Simpósio Diálogo Brasil-EUA em História Ambiental, PPGHIS,UFRJ.

Xueping Gao, Lingling Chen, Bowen Sun, Yinzhu Liu, 2017. Employing SWOT Analysis and Normal Cloud Model for Water Resource Sustainable Utilization Assessment and Strategy Development. Sustainability.

Yumei Wang P. E., 2002. The importance of politics in engineering: lessons from a hands-on experience. Leadership and Management in Engineering, 2002, 2, 3: 27–32. Crossref, Google Scholar.