

**Natural Resource Management, Economic Systems and Sustainable Development:
An Analysis of Approaches in the Northeast of Brazil**

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The benefits that people perceive and the costs they incur from this use [of environmental resources] determine the rate at which they use these resources. In other words, the relative costs and benefits give rise to the incentives people have for protecting, enhancing, or destroying the various forms of natural capital (Dasgupta et al: 339).

Recent history has shown an increase in human-nature interactions that focus more on reshaping nature to fit the needs of society than to shaping society to fit the needs of nature. The need for an acknowledgement of our dependency on natural systems and resources is becoming increasingly apparent in today's world of alarming rates of resource depletion and degradation. The focus for change needs to be based upon an interdisciplinary, multi-faceted approach, which emphasizes the importance of scale, the "weighting" or amount of emphasis that should be paid to the various components within these systems, the nature of natural resources and local needs or wants, among other variables. Differences in scale (temporal and spatial) and the very nature of interdependent human and natural systems has led to disjunctions between these systems and, furthermore, to the improper transfer of methodology and knowledge between "developed" and "developing" countries. It is these very missed connections, the limited level of integration between the systems, and the misinformed advice and programs of many international development agencies that continue to create increasingly unsustainable levels of consumption and environmental degradation throughout the world and, thusly, great lags in sustainable development throughout the world.

Attention must also be paid to the structure and type of *incentives* used to encourage the inclusion of environmental issues in economic and social systems. Some argue for the emphasis to be placed upon the inclusion of scale-based, integrated solutions to environmental problems (Cash et al), others focus on the individual systems as isolated entities. It is important to understand why incentives are necessary in the first place, where they will come from (global institutions, national, local, person to person) and whether too much focus is on the incentives themselves and not on enforcement and/or consequences related to environmentally detrimental actions. Furthermore, what are the cost and benefits for use of natural resources and at what levels should these costs be incurred (international, government, corporate, personal)? And within the varying levels of scale and cross-discipline interaction and contributions, which variables have the most applicable legitimacy for the individual case at hand? In other words, one could argue that much emphasis should be focused on the "philosophical" nature of human-man interactions to best effect environmental conservation. This might lead to policy that focuses on education issues, which affect peoples' perception of their environment and how they relate to it. Others may argue for more focus to be on the "financial" perspectives, which would focus more on the actual allocation of monetary value to natural resources and the incorporation of these resources into market systems. Still others would argue that the most affective approach is a purely "ecological" approach,

where one focuses on the workings of natural systems and the changes that need to occur to have these systems at healthy, sustainable systems.

This paper will examine a sampling of natural resource management approaches, particularly pertaining to water as a global limiting resource, placing emphasis on the overlaps between and integration of resource management and economic systems. The following sections will question some of the varying philosophical arguments behind resource management, the valuation of natural resources, the creation of environmental service markets, and other components of the comparative advantages and environmental risks associated with different approaches to water management. In latter sections, case studies from the Northeast of Brazil will be used in order to better understand the links between water management and a developing country's long-term goals for sustainable development. Examples of differing scales, institutional structures, and challenges faced in regards to water resource management, with special emphasis on natural resource and economic pressures, will be used to analyze the history and efficacy of water management techniques which put more weight on "supply" (management focus on the *allocation* of water) compared to those that place more emphasis on "demand" (management focus on *usage* of available water supply). Although *water quality* is crucial to the issues of development, health, and overall wellbeing, this paper will not explore the issues related to quality. I hope to pursue that issue in following analyses.

The following section will look at select assumptions underlying quality of life and progress and environmental issues. The section will attempt to look at development as a tool to encourage and promote sustainable growth and environmental integrity and will argue that developing countries have a comparative advantage to industrialized countries that consistently incorporate unsustainable practices into growth and development and how the exchange between the two groups needs to shift in order to allow for this sustainable development to actually occur.

Healthy or Happy? The "False" Divide

There are many tradeoffs between a clean earth and the desire of communities and individuals alike to live their life as they see fit. Some argue that there is a trade-off in some ways between "progress" and the environment (Browne), however, I would argue that there is not an inherent conflict between those two, it is the methodology behind the "progress", or even—simply—the large-scale definition of "progress" that is in conflict with sustainability and the health of the earth's systems. Humans do not have to exist and grow in a way that contradicts a healthy ecosystem, nor should we disregard the widespread levels of poverty and inequality that plague the world today. Methods of industrial and societal growth that have been implemented by industrialized nations in the past decades, for the most part, are lacking in scope and foresight; Growth without respect to long-term goals, planning, and the understanding of resultant consequences is not growth, it is inevitable failure. And as Browne points out:

Developing countries have the potential to leapfrog the developed world's process of industrialization, thereby providing an enormous opportunity to improve energy efficiency and reduce emissions (Browne: 6).

Today's developing countries hold the enormous potential for implementing their own development in a way where they can grow in a sustainable manner, within earth's natural systems. This overarching philosophy can take the place of following the path of many industrialized nations who rely on technology to play "catch-up" with the environmental degradation associated with growth and "progress". Differing concepts of the environment, equity, and vulnerability do lead to different perceptions of urgency and action; however, there are many issues on a global scale that link an increased quality of life with long-term assurance of a healthy, balanced earth. Policy and practice need to be formatted to suit our needs, the earth and humanity's, as one.

International trade has a tremendous affect on shifting the scale of environmental impacts, but can have potentially beneficial results if developed and maintained in environmentally sustainable matter. The competition associated with open trade could drive more environmentally friendly practices. Policy instruments should be designed for "real world" conditions rather than try to make the world conform to a particular policy model. However, a great knowledge gap arises between what we understand about the earth systems and what is really happening. In addition to this, there is a great technological divide between developing and industrialized countries in that the developing world does not have the financial and institutional resources needed to promote and encourage technological advancement. Countries with the capacity for technological research have a responsibility and an advantage to encourage this research and to promote a global sharing or knowledge-transfer system. However, as is expressed by Esty and Ivanova in their analysis of international aid packages to developing countries, there are negative consequences to technology transfer:

Tying technology transfer to official aid and export promotion policies has resulted in the imposition of inappropriate technologies on countries with little capacity to choose, assess, operate, and maintain them. Moreover, few international environmental agreements contain serious enforcement provisions. In most cases, the only incentive for compliance with treaty obligations comes from peer pressure or the threat of public exposure (page unknown).

What we need is a more even playing field, where global environmental issues are actually addressed on a global scale, not in the current unbalanced systems where negotiating and veto powers of industrialized countries greatly outweigh the developing world. In the following section, I will continue to review issues involving natural and economic systems, while specifically looking at some of the misconceptions associated with market economies and their applicability to the management of natural resources. Furthermore, I will discuss theories of incentive-based decision-making and introduce their relevance in discussing natural resource management.

Natural Resources and Economic Systems

No society could, naturally, live for any length of time unless it possessed an economy of some sort; but previously to our time no economy has ever existed that, even in principle, was controlled by markets. In spite of the chorus of academic incantations so persistent in the nineteenth century, gain and profit made on exchange never before played an important part in human economy (Societies and econ systems: 43)

There are many assumptions underlying a market economy; When one says 'market economy', it implies a self-regulating system of markets-directed by prices without consideration of external factors. However, this is not the reality of markets. Markets are

created by and used by people, and people are controlled by social and cultural systems, environmental systems, political systems, etc. All of these systems have their distinctive characteristics, and all of these systems are interlinked, in theory. However, in practice and application, there is a great divide between the workings and the structure of each of these systems. For example, the rift between environmental systems and economic systems is drastic in most instances, and the important links between environmental and cultural and social systems is often overlooked altogether.

As Polanyi suggests in his critique of decision-making incentives, the shifting of focus to economic rather than social drivers has greatly contributed to the flawed assumptions that the 'real market' is a self-regulating system, which is only true if the market were to exist devoid of any outside influencing system (social, political, environmental). Furthermore, he emphasizes that although markets inevitably exist, historically, today is the first time the entire economy is controlled and regulated by markets.

The recent shift to a dependency on and domination by markets misestimates the role of wealth and production superceding societal status and other variables in the decision making process. However, I would argue that the development of market economies not only changes economic structures, but also transforms the fundamental societal structures the market itself is based upon. It is within these dual transformations that one must analyze the potential role of the market in local economies as well as the potential societal motivators that can be used to create sustainable livelihoods and resource management practices:

He values material wealth on in so far as they serve this end. Neither process of production nor that of distribution is linked to specific economic interests attached to the possession of goods; but every single step in that process is geared to a number of social interests, which eventually ensure that the required step be taken. . The economic system will be run on noneconomic motives. (Polanyi: 46).

Polanyi claims that "man's economy" is more focused on the procurement of social status than on the actual accrual of material wealth and/or goods. This only holds true in a society where social status is not attributed to material wealth, which is not the case in the current trends associated with mass consumptive globalization. When these two factors are codependent, then the accrual of material wealth may become the primary goal of the individual (in that it is a more direct, simpler task) in that it is directly associated with an understood increase in social status. Accordingly, the concept of "safety-first", where an individual will make decisions based upon least possible risk, will often lead to a greater willingness to rely on kinship ties than the disconnect of government in that there is more security in the reciprocity of those you know (Scott). This is particularly true in developing countries where stakeholders have the proverbial "more to lose" in that they are often at or near the subsistence level. Accordingly, the desire to accrue social status within a community would simultaneously increase one's access to kinship-based security from risk. The decision-making process behind the actions of a Trobrian village exemplify this behavior:

As long as social organization runs in its ruts, no individual economic motives need come into play; no shirking of personal effort need be feared; division of labor will

automatically be ensured; economic obligations will be duly discharged; and, above all, the material means for an exuberant display of abundance at all public festivals will be provided...The economic system is, in effect, a mere function of social organization. (Polanyi: 49).

However, there is a problem with this analysis when material wealth is the basis for assumed increases in social status and social status does not increase kinship-based security. Furthermore, the basic assumption that societal pressures supercede an individuals desire is flawed. This would appear to be the case in a capitalist-based society, where the goals and wealth of the individual is more emphasized than equity among the population. This leads to an interesting point of the goals of a society and whether more emphasis is placed on overall equality, equality in opportunity, or simply a guaranteed minimum (and maximum??) of survival, or the many variations within these precepts. Here is where the fundamental question lies: are the interests of the individual or the community to take priority? And how should this be taken into account within government policies?

As was heretofore mentioned, it is important to emphasize the importance of kinship-based reliance, particularly in areas where the majority is living on or near subsistence levels (Scott (Polanyi)). Furthermore, individuals or entire communities who have created local economies around subsistence rather than market systems have eliminated the risks associated with the market economy, particularly a new or emerging market economy. Scott's "safety first" hypothesis is interesting to look at in the face of resource depletion and scarcity. His assumption is that populations and individuals near the subsistence level focus greatly on the accrual of basic needs, such as food, water, shelter, and maintain a desire for the greatest amount of security to ensure survival. Once the risk associated with change does not, realistically, cause an immediate change in survival needs, then the willingness to take on risk increases greatly. Dependency on a market economy or production-based, cash economy, particularly one with limited stability due to outside factors (government instability, newness of market, resource instability, proportion of population close to borderline for their basic needs, etc). If one is to assume subsistence and local economy are based primarily, if not significantly affected by, natural resource availability and allocation, then what are the benefits/risks associated with both the subsistence model and the market model? In other words, how can the desire for security seen throughout societies be tapped into to create models of resource use and allocation that are not only sustainable, but which emphasize both the local desire for stability in the face of scarcity, contribute to overall wellbeing, and potentially alleviate some of the risks associated with impending market creation and demands?

In this section, we have seen how the factors that go into decision-making with regards to natural resources on a local level are complex and dependent upon many variables. We have also discussed some of the factors of a market economy and have seen that there are strong connections between natural resource availability and allocation and the perceived stability or alleviation of risk in an individual or community's life. In the following section, I will explore some of these ideas by looking at the connections between limiting resources, both economic and environmental and coping in the face of crises. In addition

to this, I will continue to discuss the ties and disconnects between the two systems, particularly in respect to risk management and the mechanisms it involves.

Limiting Resources and Crises: Environmental and Economic Links

In regards to a community's response to environmental disasters, it is important to have planning and long-term thinking associated with the local or regional risk management strategy. Public responses are more effective if they are based upon mechanisms and programs that are in place before the crises occurs (i.e. policies made within or after crises often do not reflect the aforementioned long-term consequences and needs and speak predominantly to short-term solutions). Furthermore, programs must be targeted, provide protection for the poor, avoid creating dependency loops among beneficiaries, and consistent with economic incentives and predominant fiscal policy targets. A risk management plan is particularly important in regions that are known to have limiting natural resources and/or "public safety nets" available to the population in the case of a disaster (economic and/or environmental). This is emphasized in the following example of the 1998 floods in Bangladesh:

At their peak, the 1998 floods covered two-thirds of Bangladesh, housing severe damage to their major rice crop and threatening the food security of tens of millions of households. Their study (Ninno Dorosh and Smith) highlights how the combination of suitable government policies including and earlier trade liberalization, well-functioning private markets, public and NGO interventions and effective private coping strategies was successful at preventing a major post-disaster crisis (Skoufias:11).

In this case, the Bangladeshi government response (referred to by Skoufias as a public "safety net") was successful because it was able to both provide immediate and effective relief to those affected by disaster and to contribute to long-term alleviation of poverty. Without this public safety net, poorest of families are put in a position where they might have to choose short-term relief from environmental/economic disaster over their long-term welfare. This might lead these families to fall below the poverty threshold, or at least to a level that is difficult if not impossible to recover from. In this way, natural disasters are particularly potent in the long-term potential for poverty alleviation. In these situations, families also have less capacity to devote to the development of the future generations' human capital (nutrition, education, health care), leading to an overall bleaker image of the long-term development potential for the population. As Skoufias indicates in his paper analyzing coping strategies in the face of economic and natural disasters, the consequence of populations relying on immediate relief "coping mechanisms" to disasters often leads to the transfer of poverty from one generation to the next:

In Latin America and the Caribbean region alone, during 1980-99 there were 38 major droughts, floods, hurricanes, tropical storms, landslides, earthquakes, volcano eruptions and El Nino episodes. The same general trend seems to be present for economic crises...during 1980-98, there have been over 40 episodes where GDP per capita fell by 4% or more in Latin America and the Caribbean (Skoufias: 23).

There are many other examples of environmental disasters or crisis causing and/or greatly exacerbating economic crises. According to Datt and Hoogeveen, the economic crisis in the late nineties in the Philippines was worsened by the severe El Nino related drought, which started in the fall of 1997; This was particularly reflected in the agricultural sectors. In the face of increasing numbers of total economic crises and natural disasters with increasing frequency and severity (Skoufias), it is important to look to the intensity of contributing factors of each of the crises (economic and natural) on an individual level. Having said this, the two events are not independent of one another and it is the total output/consequences that are indicative of the relationship. Additionally, it would be interesting to analyze the frequency of coupling between the two events (i.e. How often are economic downturns coupled with environmental disasters and/or pressures? And what is the causal relationship between the two variables? How do economic crises affect environmental resource use and pressures? How do environmental resource pressures affect the economy?) The latter of these questions are much more difficult to analyze in that there are many other contributing factor to economic welfare and environmental pressures.

Mendelsohn et al. provides an example for a methodological approach to understanding components of this relationship between economic and natural disasters. They use the analysis of the effect of resource availability (particularly water) and agricultural land-use in Brazil to show that climate variance is important in explaining the percentage of cropland in a particular region. For example, the model found that in Brazil climate normals and climate variance are equally important. It is important to note that conditions in Brazil, particularly in the Northeast, are relatively dry, so an increase in surface wetness is beneficial. Likewise, the fluctuations in surface wetness are more harmful than in regions where rainfall is more persistent and less of a limiting resource. From this data, it can be assumed, therefore, that the amount of water allocated to agriculture is directly related to the climate variance of the region and, furthermore, surface wetness equates to net revenues, but temperature variation is better in explaining the actual amount of cropland coverage, directly relating to the agricultural productivity of the region.

An important similarity between natural disasters and economic crises is that they both affect large sections of the population at the same time. The simultaneous nature of these events puts a great amount of pressure on the structure and capacity of all systems: societal, environmental, and economic. So, it is the systems ability to respond to extreme, sudden fluctuations, as well as the longer-term, gradual responses, that are key (Skoufias). Taking this into account, it is evident that the public-based initiatives, “safety nets”, must be flexible and adaptable in nature, while being specific to the contributing factors of the perceived risks for the region. Furthermore, it is crucial for governmental institutions to understand the local-based structures in place for dealing with resource allocation, economic and natural disasters (e.g. The importance of integrating governmental water management techniques into the traditional Balinese water temple systems (Lansing).) It is the cohesiveness between the local, regional, and other “safety nets” that results in the individual’s ability to react to pressing resource limitations and disasters (foreseen and unforeseen) in a sustainable manner.

In this section we have looked at the links between natural and economic disasters coupled with some of the aspects of risk management behavior in the face of pressure on these resources. I have shown how interlinked the behavior of economic and natural systems are, particularly in crises, and emphasized the importance of long-term planning and coping mechanisms. In the following section, I will begin to look specifically at water management and discuss some of the diversity of water management techniques throughout the world. Additionally, I will show how water, as a limiting resource, is a crucial resource to analyze, understand, and discuss in relation to sustainable development.

The Powers of Water

For over a century, materialist social theory has proclaimed a link between the management of hydraulic irrigation and the centralization of power (Lansing: 37).

With increasing frequency, we are seeing power struggles throughout the world due to limited natural resources, water being the most prominent. Water flows and cleanses, absorbs and changes states with the local environment, and it can help to create or to destroy the communities dependent on her for life itself. All living beings have a “hydrological dependency”, as Lansing puts it, however, there are few systems in the world such as the Balinese water temple system that genuinely organize around and praise local hydrological systems. Water has been both a cause for turmoil and conflict and used for centuries as a great source for social, economic, and political power. It is subsequently important to develop a globally-reaching respect for the power of water itself. This is seen in many traditional belief-systems, and needs to be coupled with a greater understanding of our total dependency on the continuation and consistency of clean, fresh water throughout our communities.

Roy talks about connecting human rights to a ‘true price’ and continues to discuss the disaccord between the current structure of market systems and natural systems. He not only examines this, but also continues to point out the growing disjunction between political systems and the market systems they attempt to control. He argues that the transfer of power over water supplies from the governmental arena to the private sector in many ways takes the ‘humanity’ out of decision making and further increases the rift between these ‘manmade’ systems and the ‘natural systems’:

Striking a balance between what the ‘market’ demands and what people can afford, is-or certainly ought to be-the primary, fundamental responsibility of any democratic government. Privatization seeks to disengage politics from the ‘market’ (Roy).

Although Roy does make a good, heartfelt argument against privatization, his lack of proposal for alternative, comprehensive water management is telling. As he asks very important questions, such as:

What happens when you 'privatize' something as essential to human survival as water? What happens when you commodify water and say that only those who can come with the cash to pay the 'market price' can have it?

However, Roy needs to push his argument one step further and ask the equally pungent questions of: What happens when water isn't privatized? When consumption isn't controlled? When natural water cycles are not integrated into policy and practice? Without methodology to control and allocate water resources in today's world, the same negative results of privatization and dam development that Roy so pointedly focuses on (such as habitat and ecosystem destruction, relocation of towns and villages, etc) will continue and worsen due to overuse and misuse of this fragile resource. The answers do not lie in total transfer of powers to corporations, governments, or even local communities—the answers lie in an integrated management approaches that are locally specific, created around, and subject to the powers of water resources themselves. It is a question of reshaping human systems to fit the mold of the natural systems we are so dependent on, not vice versa.

Lansing's work in analyzing the complexities of rice paddy agriculture in Bali explores a human system that has developed around and because of water resource availability, cycles, and quality in communities:

Hydrological interdependency is built into the very engineering structure of the irrigation systems, with long and fragile systems of weirs, tunnels, canals, and aqueducts threading their way down the mountainsides (Lansing: 52)

The Balinese farmers are not only structuring their irrigation systems to water systems, but their cultural, social, and even temporal systems as well. These farmers are coming from an ancient tradition that not only places great 'value' on water, but has integrated their communities, livelihoods, worship and political structure around their dependency on the resource. As Roy argues: *There is a difference between valuing water and putting a market value on water.* This is exemplified in the Balinese system, where market values are not even remotely factored into hydrological management practices. However, this type of management system is not the 'end all' answer.

Balinese water temple systems serve as an example of communities working together to understand and integrate their local natural systems into many facets of their everyday lives. This type of integration can be done on many levels, and I would argue, if done properly, could be used to transform market systems just as effectively. For a given watershed community, it is important to focus on and highlight the existing systems that are in place there and how they relate to local water resources. This may include: Religious beliefs that worship or anthropomorphize water resources, market economies that are dependent on healthy, productive water resources, or political systems that oversee water allocation, treatment, and sanitation. Through the analysis and integration of these systems into the greater understanding and respect for water systems, the full power of these water systems has a chance to emerge, rise, and be protected.

In this section, I have emphasized some examples of water resources being central to social and political structure. The case of Bali exemplifies the creation of a societal and, ultimately economic (agriculture), system in accordance to and surrounding the water resources of the region. In the following section, I will continue to discuss the role of water resources in society and in economic structures. In particular, I will look at the competing approaches to access to water resources and speak about both systems that integrate and those that ignore the finiteness of the global water supply.

Equitable Water Supply

Clean air and an intact ozone layer are classic examples of public goods. While markets are the primary producers of private goods, which are delivered to individual buyers, public goods confer benefits that cannot be confined to a single individual or group. Once provided, they can be enjoyed for free (Esty and Ivanova: 4).

According to the World Resources Institute's 2004 report, there are many competing interests between a sustainable environment and the ultimate goals of countries and the desire for control over natural resources. One issue is the concept of natural resources as unlimited, public goods. I am approaching the ensuing analysis with the assumption that water is a "finite good", in that there is a set amount of global freshwater resources that are available, and at this time, water is neither created nor destroyed. If we are to assume that natural resources are "public goods", in which they is limited authority and/or monitoring of the consumption and allocation of the resource, as is emphasized in Esty and Ivanova, then should anyone have the rights to unilaterally "control" these resources?

The challenge public goods pose is that, unless carefully managed, they trigger behavior that is individually rational but collectively suboptimal or even disastrous. Since the very nature of public goods is that individual users cannot be excluded, some individuals may choose to "free ride" on the efforts of others rather than contribute resources to the provision of the good in question. It is rational for a fisherman, for example, to try to maximize his personal gain by catching as many fish as possible as quickly as possible. Collectively, however, such a strategy leads to overexploitation of the resource and can result in a "tragedy of the commons" (Esty and Ivanova: 6)

However, the assumption of a divide between the "common good" and the "individual good" creates a template for increased control systems over the said resources. Following, how can we address the concerns of the individual, while speaking to the collective, all with the goal of managing a resource in a sustainable manner?

The use of examples of water resource allocation and pricing in industrialized nations is seen as irrelevant to those matters in developing countries. The quantity of water in industrialized countries is often "inelastic" with respect to price, making the predictability of potential needs/demands and revenues high (Briscoe et al, 1990). However, this is not the case in developing countries, particularly when the region is faced with high levels of climate variability, which add pressure to the water resources, availability, demand, etc. Furthermore, populations of a developing country may or may not connect to the water system due to income level, location, reliability, etc. As is seen in the statistics for Brazilian poor, the majority does not have access to these services and are not working

within the formal infrastructure. What does this mean in regards to water management strategies in this region? One suggestion is that it is important to understand the types of services that are desired in a region, the perspectives of the local populations and their ability and desire to pay for services:

A recent willingness-to-pay study carried out by the World Bank in Northeast Brazil showed that water users would be willing to pay between 2.4 and 4.6 times the current social water tariff in order to have reliable access to water (Musa et al).

Without in depth research and motivation coming from these locally-based components, one cannot even begin to create a sustainable water management structure on the local, regional, statewide or federal level. It is the very complexities of the relationship between a person, family, community or people and the local natural resources that makes the planning for, control of, and incorporation of these resources, such as water, into other systems such as politics and the economy or economic markets so difficult. Needless to say, the structures, behaviors, supply and quality of these resources are also highly variable and complex. In this sense, it is very important to approach issues such as water management from many different, interdisciplinary ways. Plans that focus merely on supply or the allocation of water will not succeed in integrating these plans into the daily lives of the consumers, those who focus merely on the demand side will not realize the limiting nature of the resource itself. Subsequently, if potential demands are being suppressed by supply constraints in many developing countries, then what happens when programs are initiated that help to alleviate that strain of supply? Does this mean that demand will react accordingly? How will this change the local perspectives on resource use?

In this section, I have discussed some of the perceptions of water resources as a consumable good. In addition to this, I have shown how there are disparities between natural resource management in industrialized countries in comparison to those in developing countries. In the following section, I will briefly discuss some of the contrasting issues associated with placing economic value on water resources and some of the factors contributing to valuation fluctuation and diversity.

VALUE vs. Cost: Water estimation techniques

The pricing of water below its economic value is widespread throughout the world, in both industrial and developing countries. A lot of this disparity has to do with public perception, where many countries (including Brazil) have historically considered water as a free entity. According to Musa et al, this perception has led to the focus of water management to be placed more on water resource management of increased supply, instead of pricing and demand-focused initiatives:

This preference for supply expansion to meet political objectives leads to infrastructure investments that could be avoided or postponed, thereby increasing pressures on water-dependent ecosystems. Similarly, farmers in both industrial and developing countries often pay little or nothing for publicly-supplied irrigation water. Therefore, they have little incentive to conserve water or refrain from growing water-intensive crops. Likewise, many towns and cities

charge fees that provide no incentive to conserve water, while others charge nothing at all (Musa et al: 5).

According to a review of World Bank-financed water supply projects, only 35 percent of the average cost of water supply is covered by the price charged for the water; This proportion decreases with the inclusion of irrigation services (which are predominant in the agricultural systems to be discussed concerning the agricultural systems in the Northeast of Brazil).

It is argued that poor populations, assumed to receive free water, are unable to pay the tariff that would cover the marginal costs of the water utility. In fact, the poor stand to benefit most from bulk water pricing. Currently, the poor are disproportionately affected by lack of service, and must turn to private sources and vendors, who charge high prices and whose water is not always safe. (Musa et al, x).

Who should pay for the infrastructure development associated with bulk water supply? Are local consumers willing and able to pay for this? How can pricing be used as a “tool” to increase efficiency in allocation and use? As is emphasized in the above quote, it is often the poor who are disproportionately affected by both the limited nature of water resources and the corresponding pricing and/or availability. Some argue that government regulation is needed to prevent over-pricing, others believe in the privatization of water resources to create competition and potentially within the “market”. However, regardless of the institutional structure, it is difficult to price water resources in that there are so many different uses for the same resource (i.e. life, livelihood, recreation, electricity, etc). The scale of the resource and need also makes it very difficult to regulate very long-term investment needed to sustain/implement feasible water management practices on all levels (both approaches) To further complicate matters, the value attributed to water resources are dependent not only on the use, but also the user dynamics and the supply.

According to Briscoe, in order to remedy price/cost discrepancies it is important to estimate production functions and to simulate the loss of output that would result from the use of one fewer unit of water, estimating the costs of providing water if an existing source were not available and using well-structured contingency valuation approaches (Briscoe 1996). However, when starting to attach prices to reflect economic value, to ensure efficiency in allocation, particularly in regions where water waste is totally unsupported (high levels of pressure on local water resources), it is equally important to provide the locals with a voice in the creation of the management systems at hand (“demand” or usage), in order to help support and foster the further development in economic and social valuation of water as a limiting resource (commodity?).

In this section we have seen that the “valuation” both in terms of perception and economic valuation are instrumental to the creation of water management systems. Furthermore, the allocation of economic value to a resource that has, traditionally, been viewed as a “free good”, is often controversial. In the following section, I will look at the creation of environmental service markets as a methodology for both the incorporation of natural resources into market-based structures and a potential alternative to direct pricing of water resources themselves. I will suggest a general guideline for variables contributing to environmental service markets as well as

look more in-depth into water-based service markets and the specific variable that should contribute to their development.

Environmental Services Markets: Contributing Factors and Examples

One vision of a future rural economy sees landholders receiving payments, not only for the commodities they produce but also for the environmental services that they provide by managing their properties in a particular manner. One method of achieving this is would be through Government funded stewardship payments, but a more interesting alternative would be the development of markets whereby landholders could trade not only carbon sequestration credits, but also salinity control credits and even biodiversity credits (Salvin, 2000).

To date, trading mechanisms are the basis of many environmental service markets focusing on issues such as water allocation, native vegetation restoration, and biodiversity. Before creating an environmental service market, however, it is crucial to identify the environmental resources and concerns of the affected local. Markets may be focused around preemptive management practices, restoration, or conservation.

The prospect of commercializing these services is exciting because it would overcome the current situation where public demand for environmental improvement fails to be communicated to private firms via a market mechanism. Furthermore, a system of marketable rights in these services could promote a cost-effective means of controlling environmental externalities associated with agriculture (van Beuren: 2001).

According to Hall and Rogers, environmental service markets should aim to develop and manage natural resources (water, land, etc), maximizing associated economic and social welfare in an equitable manner and enhancing the sustainability of the local ecosystem. The advantages of the creation of environmental service markets to promote ecological restoration, conservation, and increased quality of life is that these benefits are the automatic *result* of local economic development instead of being the primary *foci* of action.

If such markets were to exist, landholders could choose to protect an endangered ecological community, plant trees on a critical recharge area or establish perennial native grasslands. They would do so, not because they were compelled to do so by regulation, but because these options were financially attractive when compared with traditional enterprises such as sheep or cattle (Salvin, 2000).

Substitutions and transfer of goods and services are intrinsic to the workings of today's markets. As Dasgupta et al. argues:

The relative economic values of different natural resources also depend on the extent to which such resources can substitute for one another in economic activity and, more crucially, in preserving life itself (Dasgupta et al: 340).

However, with the creation of “environmental services markets” as well as the incorporation of social and natural capital costs into existing markets, oftentimes practices of substitution directly conflict with the characteristics of affected resources. For example, financially, a government might want to substitute the production of wheat for rice production, which might make financial sense in that (theoretically) there is a rise in demand for rice and, subsequently, higher prices. However, the increase in water resources needed for rice production compared to that of wheat is significant. The government cannot then ignore water resource issues in exchange for increased attention being paid to fuel emissions. However, there are some examples, where the concept of environmental service substitution may be applicable: e.g. the use of ethanol in place of petroleum for automobile transport.

The creation of environmental services markets, however, is directly dependent on local variables concerning governance, environmental and social conditions, resource availability, and scale, among other things. First and foremost, it is necessary to compile sufficient information concerning local resources: sources, distribution, quality, costs, etc. Furthermore, the following variables should be considered:

- Institutional components of the resources and said markets
- Regulatory components
- Determination of uses/allocation/access (source) of resource
- Scale of market (local, regional, national, international)
- Determination of political setting (i.e. is water source interboundary, who is upstream/downstream, etc)
- Accessible technology/education levels
- Preexisting applicable markets (i.e. forestry, agriculture, hydroelectric power, tourism, etc)
- Info concerning local supply and demand

Market availability and definition is directly correlated to resource access and management. Within these structures, the environmental service market has the ability to both accent and influence the nature of water resource management. Informal markets are often beneficial to localities where infrastructure and/or capital is lacking, however, they are restrictive in scale and can be difficult to transform into formal markets. Formal markets are more sustainable, however, they usually require the cooperative effort of numerous participants (consumers, workers, municipalities, institutions, etc).

In addition, for a market to operate, there must be a market driver; that is buyers must consider it of benefit to them to acquire the product or service (Silva, 2002). Thereby, it is important to structure the environmental services market with regard to the following questions:

- *Can payment for environmental services (PES) be an instrument to benefit farmers, rural communities and indigenous communities that practice environmental conservation and/or sustainable development?*
- *If yes, what conditions should exist and what opportunities and conditions already exist for these actors to participate in the management and share the benefits of resources deriving from CES?*

(Brasil, 2002)

In order to allow participants to benefit from environmental conservation, the creation of environmental service markets utilizes many different participatory incentives, such as:

- environmental taxes and subsidies
- tradable permits and credits
- environmental accreditation
- eco-labeling
- performance bonds

However, before these incentives can be applied, participants in a market must also:

- Identify ecological conditions/functions that provide direct benefits to local population
- Ask if the resource, if managed more environmentally, provide and increase/improvement in local environmental services?
- Are services quantifiable and what are the monitoring tools?

The majority of environmental services are domestically oriented, both due to infrastructure and the nature of applicable resources (land, forests, carbon can be referred to a specific location/source that is relatively unchanging). However, in the case of water, which is a continually moving, transforming, and shifting resource, which often crosses international boundaries, there is both an increased complexity to the development of water-related service markets, but also a positive allowance for the expansion and diverse application potential for these services. Furthermore, currently the environmental services markets are focused in and dominated by U.S. and Europe, which allows for great growth potential in developing countries.

The development of environmental service markets in developing areas such as Latin America should not, however, be an attempt to mimic preexisting, Western markets. It is important for participating localities to consider local variables specific to their region. In addition to this, the scale of these markets is different. In rural Latin America, it is less likely to develop a corporation-driven environmental services market than grassroots, local markets. In this regard, one should consider:

- Socioeconomic restrictions in education, health, income, and infrastructure (Brasil, 2002)
- Water-related environmental service market must fit within these coordinates
- Often rural populations with little access to municipal resources
- Victims of water-resource privatization and/or poor municipality controls to water quality
- Often dealing with impending high-levels of environmental degradation
- Often have little if no formal allocation of resources (i.e. cost-allocation to natural resources/water)
- Potentially high rates of illiteracy

- Many tropical/subtropical and/or drought prone areas
- Potentially unstable political systems
- Often high-levels of poverty: few fiscal capital, great amounts of human capital

Many see water markets as a tool for providing the economic incentives for the users of water resources (Marino et al.). They argue that these markets are more flexible than other mechanisms of allocation, however, market-based solutions to environmentally-based resource management can also be problematic in nature. It is true that efficient and broad-reaching institutional frameworks are key to the efficacy of a water market, however, it is these very institutional frameworks that are both complex and imbedded, as well as, inherently difficult to alter. Marino et al. remarks that there are many variables necessary for a water market to be successful:

The existence of a user-based management approach, with structures providing transparency and accountability among members; well-defined measurable and enforceable water use rights, including those concerning return flows; and adequate knowledge of the resource available for trading, either from a known and controlled source or from supplemental resources transferred from other basins (Marino et al: 8).

The approach that they support is one in which the government and the water user are involved in the water allocation process, which, as they argue, is one of the key factors that allows water market techniques and other more policy-driven approaches to water management to be quite similar.

Water markets can provide the appropriate economic incentives to improve the efficiency of water use and encourage the reallocation of water to higher-valued uses without encountering the traditional opposition of existing water users. If a country has little experience with private markets for allocation scarce goods and services, water is unlikely to be one of the first goods exposed to private market forces. In contrast, in a country that is exploring new ways to use the private market to improve the allocation of publicly managed resources, scarce water may be a good candidate for market trading, depending on one's view of the requirements for market exchanges... Many problems can be dealt with through the manner in which water rights are designed, quantified, allocated, monitored, and enforced (Diner).

The creation of water-related environmental service markets directly depends on issues of local property rights associated with relevant water bodies/resources. Water governance not only affects the allocation of water resources, but also impacts the costs, management, and quality of these resources.

Water Governance refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society (GWP, 2000).

Water governance greatly affects the local relationship with water resources, both practically (modes of use, location of main sources, etc) and regulatory restrictions or lack thereof. According to Hall and Rogers, there are four main governance structures in respect to natural resources:

Open Access: resource is available without restrictions on user, amounts/allocation, or maintenance

Common Property: There is a specified management group who determines the rules and participants, these members have right and duties for usage and maintenance, hold rights, but others may use under the guise of set regulations

Private Property: Resource is owned by group or individual. Set rules and regulations, and users.

State Property: Water is controlled by the State (acts as a representative for the resource) and users must abide by set access and use rule set by the State.

There are numerous approaches to the development of environmental service markets, however, according to Johnson, White and Perrot-Maître, there are three main categories of financial incentive mechanisms in water-based environmental service markets:

- self-organized private deals
- trading schemes
- public payment schemes.

Although these are guidelines for water-based service markets, within a market, it is likely that there will be a combination of these mechanisms. Some common existing environmental services markets that incorporate these methods are:

- Credit and Tax Incentives
- Cost-recovery tariffs
- Deposit-refund systems
- Resource use charges
- Water charges (charges on natural resource exploitation, water charges for use and pollution, etc)
- Conventional taxation

(World Bank, 1998)

Cost-effective approaches to the creation of water-related environmental service markets will often utilize low-technology, grassroots approaches to solving environmental problems. Some key components of the markets include: water quality, flow regulation, water supply, aquatic productivity, power generation, transportation, ambient experience. Additionally, successful markets will couple environmental and or quality of life/health concerns (e.g. poor water quality and deforestation; health and water quality, etc) with the application of the services provided and/or economic pressures of a region, creating a more efficient and sustainable service:

- Reforestation support instead of focus on filtration
- Education of farmers to provide organic foods, promoting health and reducing chemicals in water
- Land-use management to protect water sources and reduce filtration needs

- Support for local agriculture and products, reducing emissions from transportation and excess packaging (sanitation)
- Trading of “pollution credits” (when applicable)
- Municipalities that protect more watershed area receive a larger allocation of tax funds, which initiates downstream-upstream communication
- Support of environmental research & carefully monitored “ecotourism” to promote business and reduce environmental degradation

Forests and water-related ecosystem services:

- Forest cover keeps maintains water table levels
- Trees shade rivers and help to maintain water temperatures
- Reforestation of steep slopes reduces erosion and sedimentation for farm irrigation and human consumption
- Forest restoration and organic farming protects infiltration zones/fish hatcheries

(Johnson, White and Perrot-Maître)

In this section, I have outlined many of the variables that are necessary to the creation of environmental service markets and water-related service markets in particular. It is evident that the success of these markets and/or applicability of their formation is highly dependent on societal, political, and environmental system structures in a region. Furthermore, it is important to emphasize that environmental service markets are not applicable on a large scale to all and/or many situation in regards to water resource management. However, there are components to most resource management systems that can incorporate some of the guidelines and niches associated with environmental services. In this way, the creation of water service markets can serve as a tool for the integration of water systems into economic systems in a region.

In the following section, I will continue to look at water-related environmental services, however, I will attempt to outline the applicability of this approach to existing systems.

Water-related Environmental Services: Market Availability

According to combined market research, global water-related markets accumulated revenues of approximately US\$655 billion in 2000, which is equivalent to two percent of the world’s GDP. At this time, 29% of this market was captured within U.S.-based corporations, which is a very strong indicator of the growth potential of similar, expansive markets in developing countries, particularly with increasing climactic and population pressures on water resources. Within the both public and municipal sectors, the distribution of water-related market revenue is dominated by the costs of water distribution and ‘other’ costs:

The accumulative cost of *public* water supply:

Water treatment 15%

Distribution and Other 85%

The accumulative cost of *municipal* wastewater:

Water Treatment 25% Distribution and Other 75%

The accumulative cost of *industrial* water supply:

Wastewater treatment 85% (compared to 60% for *water* treatment)

(McIlvaine, 2000).

These trends indicate that there is a large forum for the creation of water-related environmental service markets in regards to locally-based water conservation; As a limited resource, where distribution predominates market revenue, investment into 'best practice' and water conservation management services-particularly in drought-prone, rural (where distribution costs are often heightened) and tropical regions-would not only reduce total costs of water for local populations, but would also facilitate lucrative, locally-based markets. Coupled with water conservation services, local collection processes are fundamental to water-related service markets. In lieu of greater municipal subsidizing of water, which often leads to poor resource management, the development of interdisciplinary tools for water collection, treatment, and distribution would enable local communities to develop small-scale market economies, while preserving and conserving the local resources upon which their well-being and livelihoods depend. Some examples of these applications include:

- Mechanisms for water-related services from forests (i.e. natural buffers, sustainable forestry practices, value in water transport)
- Water quality and food security in a region
- Water-rights allocation for the region
- Flood control methodologies
- Agriculture and irrigational needs
- Animal husbandry
- Ecotourism/Leisure
- Sanitation
- Fishing
- Women's' Empowerment and Relationship to Water Resources

In rapidly developing countries, such as many of those in Latin America, the introduction of new chemical technology (antibiotics, hormones, pharmaceuticals) and the subsequent impact of these chemicals on water systems creates a need for action and educational services within the environmental services market (State of the Planet, 2004). For example, if a region is able to rejuvenate polluted local water sources through the education of local cattle farmers (prevention of fecal/hormone contamination) through basic border construction along rivers and creeks, this will provide local residents with access to clean, local drinking water sources, alleviating the communities' need to pay excess distribution costs.

Within Latin America, there is great potential for creating environmental service market, which both serve to stimulate local economies and quality-of-life, and supports the

conservation and preservation of local resources. Through the creation of market economies based upon services rendered, these markets can potentially not only avoid the controversial allocation of specific value to natural resources, but also initiate the education of populations to the inherent value of preserving their local environment. However, it is important to realize that, although a focus on the creation of environmental service markets within a water management plan can be beneficial for the conservation of the resource and local economic development, it is not applicable in all instances and, more importantly, should only serve as a component of the total plan, not the “solution” to water management on any scale.

Understanding the water sector in a region is very complex in that it involves understanding not only the factors that are directly related to water including availability, water infrastructure, uses, water policy, etc but also exogenous factors such as economic development, boundary and right issues, poverty alleviation, social values, etc. All of these variables are interdependent and are necessary for a true evaluation and understanding of “water-related” issues in a region. However, in the following sections, I will attempt to examine small segments of water management in particular, using the example of Ceara, Brasil as an exemplary case study for many of the endogenous and exogenous factors contributing to water management throughout the world.

Accordingly, in the following sections, I will look specifically into case studies from the Northeast of Brazil to discuss various approaches to water management techniques within one region. The focus on the Northeast of Brazil in regards to water management makes sense in both a historical and comparative context. As the previous sections have emphasized, there are many conflicting variables contributing to both natural and economic systems, populations’ response to natural resource pressures and supply/demand characteristics, and philosophical differences and similarities that underlie the numerous components of water management globally, nationally, regionally, and locally. The Northeast of Brazil both represents a region that is notorious for prolonged periods of drought and for the broad range of water management techniques that have been applied there on all scales. Furthermore, this region represents a population that has historically been amongst the poorest in Brazil and directly reliant upon water resources for their livelihood, which is predominantly agriculture. For these reasons, amongst others, this region serves as an exemplary model for the analysis of water management and its’ ties to economic development.

Water Management and Economic Development in the Face of Uncertainty: The Case of Northeast Brazil

According to the 1997 Brazilian Ministry of the Environmental data, it was estimated that freshwater availability in Brasil is approximately 12% of the world’s total. However, it is the uneven distribution of these resources that leads to great water pressures in many regions of the country. The semi-arid region of the Northeast contain 13% of the total national area, 35% of the population and a disproportionate 4% of the countries freshwater resources. Furthermore, more than 50% of Brazil’s poor live in the Northeast and two-thirds of the country’s rural poor, with a predominant number being

agriculturalists that directly depend upon the very limited supply of water for their livelihoods. Water, as a limiting resource in the Northeast, has led to a long history of poverty, famine, increasing levels of inequality, conflict and broad arrays of local, regional and federal water management techniques. The Northeast of Brasil has historically has also been seen as a classic example of an informal economy. It has been stricken by drought and subsequent famines, with little governmental role until the 1960s:

Poverty became synonymous with the lack of water and clear title to the land. A small number of big fazendas, the ensuring centers of oligarchical power, monopolized the perennial water sources and were usually well protected from drought, but the rest of the population in the semi-arido was pitifully dependent upon the erratic rainfall. Every year the sertanejo made a desperate wager with a devil we know as El Niño. (Davis, 386).

The climatic variability in the region of the Northeast subsequently created a semi-nomadic culture of farmers due to the variations in land fertility and rainfall. Following, a lot of resources (money and labor) has gone into the multiple seeding of land due to rain fluctuations, wash-outs, in order to secure a minimal harvest for the rural poor. In addition to this, throughout the 18th and 19th centuries, immigrant labor and new settlers originally brought labor-intensive style of farming from Europe and other non-tropical regions that didn't correspond with the ecology, dryness, and infertility of the soils of the Sertão.

During the 19th century, the Northeast region was plagued with extreme drought and subsequent consequences; The drought-famine of 1825 killed 30,000 people in the state of Ceará alone. This was followed by El Nino droughts 1888-1902 and sustained levels of very high pressures on water resources:

The economic and political hegemonies, respectively, of the British and the Paulistas, plus the northeastern oligarchs' depending investment in their own underdevelopment, thus explains much of the structural context of the century long burlesque of "irrigating the Sertao". In the wake of successive El Ninos, national commissions and visiting foreign irrigation experts drew up sweeping, never-implemented plans for stabilizing agriculture and human settlement in the backlands. The few hydraulic projects that were actually built, beginning with the Acude Quixada reservoir in Ceara in 1899, "stored water which benefited large landowners and protected their cattle by providing pasture and watering facilities but....left most of the low-income agricultural population untouched." Only 500 hectares of the sertao had actually been irrigated by 1941, and twenty-seven years later, when a military dictatorship worried about possible Guevarist focus in the Nordeste hired Israeli consultants to conduct the first comprehensive irrigation survey, conditions of life ro millions of drought-stricken and immiserated sertanejos were little different from the days when Conselheiro and Cicero first preached Apocalypse on the backroads of Ceara. (Davis: 392).

The population in the Northeast of Brasil has more than tripled since the 1950s, and the rapid levels of both urbanization and industrialization in the region, without the appropriate time for adequate infrastructure development, has led to increased levels of demand and critical levels of pressure for water. In the Brazilian Constitution, there is a distinction between Federal and State waters, which has led to many state-based water laws and management initiatives, which may or may not in the long run coordinate with

Federal-scale water laws and management initiatives. The urgency of water scarcity and extensive droughts in the Northeast, has historically and continues to be a major obstacle in the economic and social development of the region. The push for increased decentralization in recent years has also led to increasing amount of state-level water management initiatives.

Recent Bank economic and sector work (e.g., *Water Resources Management: A World Bank Policy Paper*, 1993, and *Brazil Management of Water Resources*, LA1 Economic Notes #4, World Bank, September 1995) have identified two fundamental deficiencies in water resources management which apply to the Brazilian Northeast:

(a) *Management of water demand is inefficient.*

According to them, the public agencies in the region have little reliance in their management capacities and collaboration amongst sectors has been lacking. Furthermore, water management has historically been highly centralized (it will be pointed out in a following section that this only applies to water users who have access to public resources, which is very low percentage of the population) and, coupled with this, there has been little user-policymaker interaction. The World Bank also assumes that the historical perception of water a public, free good has greatly impeded to development of “adequate water-use rights systems” and they support the shift of perceptions to that of an economic good with the potential for allocation to the private sector (*Water Resources Management*, 1993), which directly implies the need for the “privatization of water resources;

(b) *Management of water supply is weak.*

Storage capacity in the Northeast is insufficient and/or poorly operated and managed to carry the region through frequent dry cycles and has deteriorated due primarily to the lack of adequate maintenance. In addition a large number of unfinished projects are spread throughout the Northeast.

Furthermore, according to the World Bank’s strategy for assistance in Brazil, they support stability:

The primary emphasis is on efficient resource allocation, increased efficiency of the public sector, appropriate incentives to the private sector, improved environmental management and appropriate targeting of services for the poor (World Bank, PID81111, 1997).

According to a report detailing the rural/small community water resource provisions throughout Brazil, the World Bank attempts to implement project designs that focus on alternative service delivery models, gradual investment, sound financial policies for subsidies and applicable tariffs, and the subsidizing of access components to water resources in lieu of a focus on consumption subsidies. Overall, they claim to attempt at adopting increasingly integrated approaches to water supply management throughout Brazil (WB, 2003, **PID8172** p 6), where states and water users maintain a greater participation level in the management of water resources. Accordingly, they infer that the rural population of the semi-arid zone of the Northeast will benefit the most from infrastructure development and improved supply, while urban populations in the region

will benefit increasingly from the boost in economic activity in surrounding rural regions (due to the improved infrastructure) as well as the increased availability of water supplies (World Bank, PID81111, 1996).

This section has outlined some of the historical background behind water management techniques in the semi-arid Northeast of Brazil. It has emphasized the climate variability and water pressures, coupled with increased levels of agriculture and population that have occurred in the region throughout the past two centuries. Furthermore, I have presented some of the World Bank philosophies behind the necessary tools for water management in the region (with the World Bank being a major source of funding for the majority of water management projects in the past decades). In the following sections, I will attempt to analyze and discuss in more specifics the differing attributes of water resource management programs that have been applied throughout the region and, in some cases, their applicable efficacy, particularly in respect to the comparative advantage of the varying methodologies. The proceeding section focuses on the concepts of supply versus demand in the face of water management programs. Furthermore, I have separated the examples into Federal, State and Local examples in order to see the variety and potential conflict/agreement between the different management levels.

Supply vs. Demand: Water Management in the Northeast of Brazil

For instance, since path-dependency and other self-reinforcing mechanisms tend to reinforce the current course of development path, it becomes extremely difficult or very costly to reverse the course of the ongoing path (North, 1990a: 99). The fact that institutional components are nested in a hierarchic structure also implies that the components at each level are more costly to change than the previous ones (North, 1997: 6). Similarly, the fact that the formal institutions are embedded within other formal and informal institutions not only minimizes their collective transaction costs but also enhances their mutual performance (Saleth et al, 5).

This observation by Saleth et al in respect to water reform and the role of institutions infers the importance of the history of water management policy within a region. Due to the scale of most water management initiatives, once policies and/or infrastructure are begun, it is incredibly costly to take on measures that are conflicting. Water institutions are directly dependent upon the nature of the resource in the region; Thusly, the structure and linkages of the water institutions in the Northeast of Brazil should accordingly reflect a history of limited water resources in the region. The institutional structure in the region directly affects the regions ability to enact political pressure for change in the region as well. (Saleth et al9). As they continue in their analysis, Saleth et al points out that that the net benefits for institutional change in a “crisis-ridden water sector” are quite high due to the assumed impact and emphasis on affected water resources. Particularly in regions where there is history of “water crisis”, there is also political legitimacy and importance placed on the role, function, and structure of policy, use and institutions in the region. This phenomenon has been observed with the amount of money, resources, and attention that has been paid to the Northeast region of Brazil in the last few decades. The state of Ceara is considered by many to have implemented and initiated some of the most radical water reforms in the country. The chart below emphasizes some of the pros and

cons, according to Manus, of different approaches to supply-driven (allocation) water management techniques in the region.

Table 2.1 Advantages and Disadvantages of Various Water Allocation Mechanisms

	Marginal cost pricing	Public allocation	Water market	User-based allocation
Advantages	<ul style="list-style-type: none"> Theoretically efficient, and minimizes overuse. Easy to combine with taxes to internalize externalities. Easy to adjust to varying water supply quantities. 	<ul style="list-style-type: none"> Promotes equity objectives, independent of the charge. 	<ul style="list-style-type: none"> With appropriate design achieves high allocative efficiency. Allows internalization of externality costs. Flexibility in responding to changing market conditions. Allows compensation. 	<ul style="list-style-type: none"> Flexibility to adjust to local conditions. Political acceptability. Easy to adjust to varying water supply quantities.
Disadvantages	<ul style="list-style-type: none"> Time-span sensitive. Depends heavily on nature of demand. Neglects equity issues. Difficult to implement. 	<ul style="list-style-type: none"> Fails to provide incentives for production and use efficiency. Subject to political pressure. Inflexible with regard to inter-sectoral allocation. 	<ul style="list-style-type: none"> Sensitive to existing physical, legal and institutional frameworks. Sensitive to level of transaction cost. 	<ul style="list-style-type: none"> Heavily dependent on local capacity. Diseconomies of scale to institutional management.

As is outlined in the above chart and was discussed in depth in the previous sections of this paper, there are both advantages and disadvantages to the numerous approaches to water management in a region. It is often the assumption that the majority of water problems are from inefficiency of use instead of the limitations of the water supply itself (Saleth et al.). However, it is important in policy and management techniques to address both issues with a varying emphasis placed upon “supply” pressures and “demand” or use pressures. The case study for Ceara, Brasil, a state in the semi-arid region of the Northeast of Brazil, is exemplary of a region where both supply AND demand have been in the face of extreme pressures. As heretofore mentioned, these pressures stem from the frequency and severity of drought in the region coupled with the continually increasing population in the region.

Federal Action

As of 2000, Brazilian census data showed that approximately 10% of urban and 80% of rural population still have no access to piped water supply. IBGE social indicators for 200 showed that under on third of the poorest 40% of population have access to water services and sanitation, where 80% of the richest “decile” have those services. Furthermore, the North and Northeast have the largest discrepancies in the access (percentage of population with) to water and sanitation services. According to the World Bank’, the reasons behind the lack of systems is the inefficiency of water systems that are handled by the municipalities themselves, the corruption within the systems, and the total lack of municipality involvement in the rural sectors. Accordingly, federal government strategies have tended to focus on “funding” in exchange for work/civil works/construction projects, which do not incorporate the costs, tariffs, incentives or other attributes of water service provisions (WB 2003, **PID8172: 2**).

The National Policy for Water and Sanitation is to provide universal access to water supply services by 2010 through methodology focusing on modernization,

reestablishment of investment (new sources for financing) and “compensatory activities” or incentives, which are aimed as a response to the services needs (demands) of the low-income citizenry. Furthermore, in 2001 the federal government of Brazil proposed national guidelines for the water sector that aim to create effective means for universal service provision by: 1) Delineating the time structure and need for the states and municipality to manage services, 2) The delegation and regulation for public and private service operators, and focusing the resources on providing for those who are not currently include in the system. The World Bank gets involved in the project designs through financing and the integration of BMPs (Best Management Practices) from other countries. According to them, they are looking to the “long-run sustainability of services...therefore confronting the complex issues and trade offs that such an approach involves”:

*Supply versus demand experience has shown that investments in WS&S undertaken in a supply-driven, paternalistic manner are not sustainable. With no participation in the decision making process and little consideration of cost recovery, communities generally lack a sense of ownership and responsibility for such investments. Since, in addition, they often do not pay-or are not required to pay-their bills, there is a resulting rapid deterioration in the services provided. ..by switching the approach from supply driven to one which stimulates, and is responsive to, demand, from the community, municipal and state stakeholders, respectively...Such participatory approaches have been shown to produce more sustainable project results at lower costs and to contribute to the formation of social capital empowering participants to gain benefits not originally associated with the project.” (WB 2003, **PIB8172**: 5)*

The 1997 Federal Water Law states that all water is public property, however, in many regions this is not enforced and local understandings of water rights continue to dominate. As Marino et al remarks, throughout the Northeast, public dams have been privately appropriated as well as private dams constructed without state or federal permission. Accordingly, in 1992 Ceara passed its first Water Resources Law, however the main water resource managing body in the past has been allocated to the National Department of Works against Droughts (DNOCS). Accordingly, the World Bank has emphasized the importance of the collaboration of the many levels of water management, while praising the progress of particular states in the Northeast:

The States of Ceara and Bahia, where the Bank is preparing State Water Resources Management Projects recognize the importance of complementarity between the proposed Federal Project and their own State projects. In addition to Ceara and Bahia, the States of Rio Grande do Norte, Minas Gerais and Pernambuco have achieved significant progress towards the establishment of their water resources management systems and have already indicated their interest in obtaining Bank support for future State Water Resources Management Projects (World Bank, 1996).

Interestingly enough, the locally-managed case in Cariri, a southern region of the state of Ceara, gives a predominant right to upstream farmers and even went as far as to ensure the forfeit of downstream farmers’ water rights in the face of decreasing resource availability (contractual agreement of 1854) (Marino et al); Furthermore, the region has relied upon local, not federal or state, enforcement of water allocation. Accordingly, the increasing role of the state in water resources in this region is actually detracting from the efficacy of the existing programs. The case Marino et al makes is that the existence of

the local-level water allocation methodology has allowed for a successful trading of water rights within the region. However, the relevancy of this case study to the policy and methodology of other regions, which are both demographically poorer and water-stressed is negligible at best. To their credit, Marino et al. does allow for some of the demographic misgivings in using the Cariri regions example as a template for programs in the rest of the state. However, they site the small size and personal connections between participating farmers and the absence of state intervention as the reasons for this, neglecting the aforementioned, encompassing issues.

The goal of the Sustainable Integrated Water Supply and Sanitation in Small Municipality program funded by the World Bank in 2003 was to target poor municipalities (<20,000) for improved access to water and sanitation. The approach of this particular program was to create 'local integrated sanitation plans' incorporating institutional, technical, etc components for greater access to water-related services. In addition to this, there is a large emphasis on the integration of 'best-practice' approaches in these regions. Many of the World Bank initiatives have worked to dually help increase poverty reduction and water allocation in a region, emphasizing the causal relationship between the two factors. Interestingly enough, many of the projects are not necessarily linked with environmental reforms and appear to focus more on anthropogenic uses/pressures associated with water resources in the region. In the case of the World Bank Small Municipalities project of 2003, there is an emphasis on environmental assessment, however, no emphasis to natural habitat. From the numerous studies read, it can be generally assumed that the predominant analysis and action in regards to water resources in the Northeast region focuses on quality and quantity of water for human consumption and other anthropogenic uses. Although this is, arguably, a potentially detrimental approach to water resource management (in that the resource is a part of a greater ecosystem and is dependent upon the health and viability of the system) that human-related water issues have been focused upon in this region due to the scarcity and pressures associated with water resources there. Interestingly, much of the policy in the main "spotlight" is associated with other states in Brasil tend to focus on issues of biodiversity and forest management (Amazonia in particular) in relation to water source availability and quality. The difference between the two approaches is most likely due to the variation in statistical data for the two regions.

In this section, I have reviewed some of the Federal approaches and regulations pertaining to water management in the Northeast of Brazil. In the following section, I will take a closer look at the state of Ceara and some of the state-wide as well as regional approaches to management there.

State Approach: Water Allocation and Trading in the Cariri Region-Ceara, Brazil

It is argued that Ceara has been a pioneer for five reasons, namely:

- 1. Water in this state is very scarce since there are no perennial rivers in the region; therefore, water management is of paramount importance to overcoming the annual dry season and drought periods;*

2. *Because of this severe water scarcity, Ceara does not have the means to generate hydroelectric power. Consequently, the state does not receive a share of the legal financial payments that are accrued from the energy sector and which provide a "free" fund to water resources management in the regions where hydroelectric plants are located;*
3. *To cope with this absolute and seasonal scarcity, about 7,500 reservoirs were built in the state. Yet these reservoirs have not been successful in providing a reliable water supply, and dramatic shortages continue to occur during severe drought seasons, as occurred in 1998. Federal government investments had almost disappeared in the public deficit crisis of the 1980s, so the state had to fund this massive investment;*
4. *Ceara has been promoting an aggressive program of industrialization and coastal tourism, taking advantage of its low salary economy and land prices. Clearly, a reliable water supply is a key factor to the success of this program; and*
5. *There is no major federal river in Ceara. Consequently, the state government is free to implement its own policies, without waiting for federal regulation."*

(Musa et al: 21).

New water resources management systems in Ceara are currently emphasizing the participation of water users in the allocation process, particularly through the creation of water markets. This recent development has helped to shift the responsibility from federal government agency and inter-personal arrangements between users to the role of the state as a larger player in management issues of the state (Marino and Kemper). They continue to use the example of Cariri, one of the southernmost regions of Ceara, as an example of a successful water market (albeit flexible in definition):

Another valuable example is from the Cariri region in the state of Ceara, where a system of tradable water rights has existed in Brazil for over a century. While the Cariri experience represents a small isolated system, it provides a number of useful indications concerning the value of water, the possibilities of allocating and enforcing water rights in rural areas, and the willingness of water users to pay and cooperate in order to assure a secure water supply (Musa et al: page unknown).

Their emphasis is in the incorporation of commercial transactions of water resources between local farmers and a perceived "flexibility in the use of the resource". It is arguable whether this flexibility is a potentially positive or negative effect, particularly in the face of a severely-limited resource. It is important to look at this from the perspective of the farmers who are participating in the structural framework (How has a shifting approach increased their perceptions of water-security? And how does this relate to the empirical evidence of changes in allocation, efficiency of use and reliability of supply?).

The existence of local water allocation methodology is key to understanding the effects of external mechanisms for water management (on the regional, state, federal, etc level). Interestingly enough, the region of Cariri is home to some of the wealthiest populations of the state, which directly relates to the relative abundance of water resources in comparison with the rest of the state (Marino et al). This disparity between the Cariri region and the rest of the state raises an issue to the use of management techniques in this region in comparison to the overall proposed state reforms. If the majority of the state is both plagued by consistently high level of water pressure in regards to water resources and home to the countries most concentrated population of rural poor, the analysis of a relatively "stable" region, with some of the wealthiest populations of the state, in terms of these resources is inherently flawed. This is particularly the case when relating it to the efficacy of water market systems on the state level. It is precisely this type of analytical comparison (choosing case studies that fit the "hypothesis" or desired outcome (in this case, it is the promotion of successful water market tools-Marino et al.) that results in

disastrous advisory tools from organizations such as the World Bank to developing countries such as Brasil. This type of “weighted” analysis not only has the potential for the adoption of detrimental environmental policy, but particularly in the case of Ceara, has the potential for negatively impacting the state’s and populations’ potential for sustainable growth and development (economic, environmental, etc).

Bulk Water Pricing

Ceara is the only state in the country (as of 1999) where bulk water fees are charged to the state company for the withdrawal of water for the general potable supply. Ceara serves as a primary example of state-level management techniques in a region where water supply is very limiting. In this way, analyzing the numerous approaches taken in this state (and some examples from surrounding states) serves as a case study in determining the efficacy of the numerous techniques attempted and implemented and the connections with sustainable development and water resources in the region. In November 1996, Ceara became the only state to introduce bulk water tariffs for municipal and industrial water use. Additionally, there is a “bulk water tariff” in place in that state, which is based upon a flexible tariff. The below chart outlines the Bulk Water Pricing Structure in Ceara.

Table 3.1. Bulk Water Pricing Structure in Ceará

	Current Prices (US\$/1,000 m ³)	Estimated Annual Revenue (US\$ million)	Proposed Prices (US\$/1,000 m ³)	Estimated Annual Revenue (US\$ million)
Industrial	545.50	100	663.60	121.65
Municipal	9.10	250	11.10	304.95
Irrigation and aquaculture	---	150	1.10	185.78
Others	---		11.10	
Total	554.60	500	686.9	619.27

Note: exchange rate - R\$1.10/US\$1

(Manus, pg20, data as of 1999).

The difficulty in Ceara is that is one of Brazil’s poorest states, with an immense rural poor population that depends upon irrigation for agriculture. Because of this, there is not much flexibility in the pricing of water resources for the majority of the population (according to Manus, 1999, the state per capita income was less than US\$2,500.0 per year). Putting even more pressure on the efficiency and low-cost allocation and conservation of water as a methodology for water management:

It is argued that they cannot even pay the tariff that would cover the marginal costs of the water utility, much less the additional cost for the bulk water supply system. These arguments usually rest on the assumption that the poor get water for free. However, numerous studies have shown that the poor are often not connected to the official water supply network, in which case they have to buy water from private vendors (e.g., Carrospipa in the Northeast), and these private vendors charge many times the price paid by their wealthier neighbors in well-served neighborhoods (Musa et al, 33).

There are many questions that this type of tariff/pricing structure invokes. Including the affects of the tariffs and pricing on the rural poor in particular regions of the Northeast.

For example, is the above quote applicable to the majority of rural poor in the state of Ceara? What is the structure there? Where do the rural poor get their water and how much (on average) are they paying? How does this compare to the costs inferred to industry and more affluent members of society/those being supplied water from the state? In order to find the answers to these questions, it would be important to focus research on a grassroots level where surveys of local stakeholders are directly affecting the pricing and regulations of water resource management by the State. Although this is outlined as one of the “goals” and “foci” of both the World Bank funding of initiatives and the state of Ceara’s emphasis on user involvement, the role and demographics of the user is not well represented in the cases mentioned above. In the following section, I will outline some of the general locally-based structures that have the potential to help incorporate local stakeholders in the decision-making process.

Local Power from Northeast Social Institutions:

Undoubtedly, there are a plethora of locally-based institutions and structures in the Northeast of Brazil, which both play a key role in and have potential for organizational motivation for local involvement in water resource management on the local, regional, and state level. As was emphasized in the example of the Cariri region, the understanding of these local institutions and practices is crucial to successful relations between the state and stakeholders, as well as successful water management. Accordingly, I have outlined below some of the proposed and existing local-management groupings that *have* been recognized by the World Bank. It is important to note that each region and community within will have many other structures that equally, if not more significantly contribute to water management practices and stakeholder involvement including religious affiliations, kinship-based structures, land-tenure structures, etc. These variables will not be discussed in this paper, however, should be explored in further research. The following are locally-based structures that have been incorporated into World Bank projects:

Municipal Development Consultation Bodies (*conselhos de desenvolvimento municipal*): These groups are composed of community members (80% of total membership) and representatives of civil society and municipal authorities (20% of membership). According to the world bank the role of the ‘community councils’ is to help define the water service priorities for a given community and to help to initiate community adherence to related projects assigned by the state and other entities. Furthermore, the Bank emphasizes the role of these ‘councils’ in the formal agreements, which will commit communities to following the conditions of the programs. In other words, the ‘councils’ serve as a body for the mobilization and agreement of communities and stakeholders to follow the rules set by the Bank and affiliated projects in regards to water management.

Community Associations: According to the Bank, community associations are legally constituted by the members of a particular community. The Bank emphasizes its attempt to strengthen and support these associations technically and financially. Furthermore, they infer that these groups are the ones who should be responsible for the structural and

developmental stages of the water services at the local level in addition to the management of these said services.

Users Associations: The Bank calls for the creation of user associations in more populous regions where the management of water resources is managed by either public or private service providers. These groups are supposed to serve as the educators and translators between the two factions in respect to water provision, understanding the communities' rights and responsibilities, etc.

Local Executing Agencies (UEs): These community bodies are located (where 'community councils' or other community associations already exist and have social legitimacy) by the local communities themselves and are to focus their emphasis on social mobilization in affected regions. They are meant to participate directly in planning meetings and assist in the decision making process throughout the development and strengthening of the formal community associations or user associations.

River basin committees and other regional associations/committees: Regional water basin committees are meant to work with other regional associations or municipal association to provide potential water management projects with applicable local solutions to management issues and the integration of the system across municipalities. (World Bank, 2003)

Although all of the above bodies could potentially play key roles in the development and integration of state and federal-level water management into the local community and local development, the language used by the World Bank to describe the participatory role of these organizations is vague at best. Furthermore, the incorporation of these locally-based groups into larger-scale water management techniques is ideal, but would be economically straining, particularly in a country the size and with the population of Brazil. Is it realistic for a country with limited economic resources to spend so much of their international assistance on local initiatives? Certainly, it is crucial to the efficacy of water management, particularly in regions such as the Northeast where water pressures are key to economic and social wellbeing. However, I question the actual allocation of funds that have been allocated to this type of local infrastructure development, particularly in the rural areas with lower levels of population density and high levels of poverty. It would be assumed, just as the access levels in the wealthier, urban regions is dramatically higher than those of the rural poor, the amount of economic resources being placed on urban development is equally as disproportionate.

In the following section, I will attempt to bring together the numerous ideas presented in this paper in regards to the integration of economic and water resource systems, all under the common goal of promoting sustainable development practices.

Comparative advantage and environmental risks: the Management of Water Resources

In Brasil, they have taken a new approach to water management on by attempting to involve users in the frameworks, recognizing them as stakeholders and encouraging their

involvement with the government in making the rules and influencing regulations. However, as was shown in previous sections, the communication between the differing levels of actors still has much room for improvement. There are many variables that contribute to the development of water management strategies and relate to the incorporation of water resources into economic systems. In regards to pricing of natural resources such as water, it is assumed that users will only be willing to pay for water services if there is an exchange; In other words, if the users are guaranteed more stability in the water supply, greater transparency in decision making, more secure access to water or contractual investment projects, then they are more likely to agree to pay (or to pay increased rates) for water services. However, the extent of expectations of the population varies dependent on the region and the local water perceptions. Pricing also has to be associated with increased monitoring and enforcement, which would be inherently more effective if implemented on a local-level rather than a regional or federal level (again, the importance of increasing local participation, so users become the major stakeholders). At the same time, it is important to have coordination amongst monitors in order to have accurate, reliable data collection and effective management on the local level.

Furthermore, it is important to reflect on the institutional structure and economic resource allocation in respect to water management in rural areas and how these levels can be altered by locally-driven alternative actions. For example, the influence of local understandings of allocation and use policy in the region could lead to local levels of water management that would work within the state-wide scale of management. Furthermore, this emphasis on local empowerment would lead to innovative methodology that is locally-specific and more likely to correspond with the limits and variabilities associated with local resources. However, as was mentioned in previous sectors, particularly in regions predominantly populated by rural poor, the levels of poverty their might lead to the propagation of unsustainable practices. In this case, the incorporation of water-based environmental service market may be beneficial to the local economic development of the region and the resource management. However, it would be crucial to incorporate the knowledge of the abovementioned, as well as other, community leadership groups to educate the local population to larger-scale resource realities as well as the creation and support by larger entities of the proposed local structures.

Although the methodology behind the direct incorporation of natural resources into economic systems is controversial, the direct influences of natural resource availability and quality on economic development and the wellbeing of a population are undeniable. Many developing countries have the potential to create and maintain systems of resource management on all levels that work with their available natural resources, such as water, in a sustainable manner, instead of depleting them. Furthermore there is a direct link between development indicators and the quality of natural resources in an area. This is most directly seen in respect to water resources in which the access and availability to water resources is a direct indicator of human development. Socioeconomic indicators are directly related to these issues as well, particularly in regions such as the Northeast of Brazil where the majority of the population is crucially dependent upon the quality and quantity of water resources for their livelihoods and survival. Dasgupta et al.'s dissection

of current estimates of socioeconomic indicators suggests that with the inclusion of natural capital (i.e. resource availability) the current set teams of “developing” and “developed” countries have the potential for change towards greater equality. What will this shift mean in terms of policy and who has more so-called political and literal global “purchasing power” and decision-making authority in the global economy? Secondly, when incorporating natural capital into a country’s wealth, it is imperative to not only look at the current resource availability, but also to compare and contrast this with the rate of depletion associated with productivity and the plans in growth within this productivity rate. Finally, I would argue that the reevaluation of “wealth” to include these aspects would not only shift the emphasis on the large reserves of potential within what are currently deemed “developing” nations to create sustainable systems of production and consumption, but would also change the negative and positive associations attributed to “developing” and “developed”. This would have the potential to create more equitable social, economic and environmental relations between nations and would also encourage a shift in the trend from continued focus on capitalistic commodity production to sustainable man-land interaction that are suitable on all scales to existing societal structures. Furthermore, this type of reevaluation of international compartmentalization could greatly contribute to the deconstruction of developing vs. developed ideas (strikingly similar to colony vs. colonizer in respect to who is the enforcer and who is the acted upon).

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