Chapter 10
Risk Management Instruments Supporting Drought Planning and Policy

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Abstract This chapter looks at the role of risk-sharing mechanisms to help alleviate and reduce the economic and social consequences of droughts and water scarcity periods. We group various instruments according to different criterions, and review their potential and practical difficulties. By categorising the reviewed instruments under the stages of drought on which are best applied or referring to whether they are targeted to agricultural and operational droughts, we provide a framework for discussing their merits and drawbacks. This same framework is also used to evaluate the potential of each instrument and the evidence available to support it. We conclude by highlighting the limitation of economic instruments to manage drought risks. In part, this is because avoiding drought effects has public good properties. The chapter concludes, based on the available evidence, that there is still potential to manage part of the drought risks using financial instruments and insurance.

Scope and Objectives

Droughts create social stress, economic losses and environmental damage. As in many other environmental and resource issues, economics, as a social science, has a say both in prescribing efficient policies and in explaining economic outcomes. Economic prescriptions and analyses are subject to considerable criticisms. Most often the attacks are based on the fact that economic models pose complex environmental systems in a very simplistic manner, disregard social and cultural dimensions, and overlook equity issues. While these are very critical issues in social decision-making, it is also the case that economics is centered primarily on evaluating the efficiency of observed results and policy alternatives. It is up to the decision makers,

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legislators and stakeholders to place more or less importance on the economic consequences of following one or another course of action.

The objective of this chapter is two-fold. First, it attempts to provide a representation of the economic risks of droughts and how they can be conceived in order to prepare agencies to become more efficient and conscious of the economic implications of droughts. Second, the chapter tries to review the policies that have potential to deliver more protection against drought effects at the minimum economic and social cost. For this, we review the most updated literature and practice, and synthesize the lessons that can be drawn from them. In general, we shall focus on the Mediterranean context, seeing it as a combination of particular climatic and geophysical characteristics rather than a world specific region.

The chapter starts by defining briefly the primary water environmental services and the types of droughts for which policies and instruments are proposed. Then, we review a number of economic instruments that can be applied to face the types of droughts that fall within the scope of the chapter. In the fourth section, we review the institutional and technical requirements of each instrument, as well as identify the major advantages and limitations. We summarise the main lessons and recommendations in the last and fifth section.

Environmental Services Linked to Water Resources

Seminal work by Costanza and de Groot (1997) provided a framework to conceptualize the value of world natural resources and assets to humankind. This framework distinguishes between ecosystem functions from environmental services. Ecosystem functions refer to system properties and processes. Services represent the benefits that society derives, directly or indirectly, from ecosystem functions. A summary of these authors' evaluation of annual flows of water-related ecosystems at world scale is shown Table 10.1. With it, we wish to highlight the importance of non-commercial water services and draw a boundary for the services we will be focusing on here.

Table 10.1 Summary of average global value of annual water-related ecosystem services (US$ $ha^{-1}yr^{-1}$)

Environment	Area Hax1	Water reg.	Water supply	Waste treat.	Habitat refugia	Food prod.	Recreation	Cultural	Total ($\$yr^{-1}$)
Wetlands	330	15	3,800	4,177	304	256	574	881	4,879
Lakes/rivers	200	5,445	2,117	665		41	230		1,700

Source: (Costanza and de Groot, 1997)

As the numbers show in Table 10.1, humans enjoy many different services from water-related ecosystems in addition to water supply. Note, for example, that one hectare of wetlands can generate almost $4200 per year in waste treatment services. While this evaluation was certainly preliminary at the time it was produced, it conveys a clear idea about the costs and damages that water scarcity can provoke. The mere recognition of many of the identified services valuable for society has huge implications for drought policy design and implementation. Chief among this is the fact that many of these services have public nature features, which means that they are non-rival and non-exclusive goods. As scientists have learned to identify and value them, water policy must take into account and ensure that decisions are compromised among both productive and non-productive services (National Research Council, 2004).

Water supply reliability, as a service that transcends use benefits, can also be considered a public good. In general, supply reliability cannot be priced, unless options contracts or some other form of risk-transfer mechanisms are implemented. For this reason, reducing water use in times of shortage is generally not stimulated via pricing mechanisms, but rather with command-and-control and rationing mechanisms. However, as we will review below, pricing mechanisms can contribute indirectly to increase supply reliability by reducing water consumption and lowering the probability of shortages.

For the purposes of the instruments we will be reviewing here, it is important to highlight the limited scope and potential of economic instruments in targeting drought's direct effects on environmental services of public good nature, including supply reliability or the management of shortages. Yet, in some of the cases we will be reviewing below there are indirect benefits attached to the protection of ecosystems on which key environmental services are based. We wish to state from the outset that environmental services, inasmuch as they are influenced by droughts, are primarily supported by command and control policies and not by economic instruments. This explains why the chapter does not pay specific attention to them.

Types of Droughts and Categories of Economic Instruments

There are numerous definitions of droughts (Vogt and Somma, 2000). For the purpose of this chapter, we will only focus on two large categories, namely, agricultural droughts and operational droughts. Other chapters of this book deal with other types of droughts and certainly policies to prepare and plan for them. Agricultural droughts occur when soil moisture is below normal levels. Water that can be used by plants has been coined ‘green water’. Of course, ‘green water’ scarcity has multiple manifestations, in addition to those pertaining to range and rain-fed agriculture.

In the same vein, operational droughts, also called hydrological droughts, ensure when available resources are insufficient to meet normal demands, including the protection of aquatic ecosystems. Operational droughts are situations of abnormally low levels of ‘blue’ water, which refers to the amount of water in lakes, rivers, reservoirs and accessible aquifers. The root of these situations is not only from persistent periods of abnormally low precipitation, but also from the criteria with which reservoirs are generally operated (Iglesias et al., 2007).

The connection between agricultural and operational droughts is obvious, as both are caused by prolonged periods of abnormally low precipitation, and indirectly by higher temperatures. But the set of menus with economic instruments to reduce social risk and vulnerability to both types of droughts is entirely different. This marked difference is especially important in Semi-arid and Mediterranean contexts.

The policies this chapter reviews are depicted in the following conceptual graph (Fig. 10.1). The following ideas are represented in the graph. First is the timing of the application of instruments with respect to the onset of droughts. There are ex –ante instruments which are meant to reduce the risk or uncertainty by taking action in advance in order to anticipate the impacts of drought. There are also ex –post instruments, which can be better developed, applied or enforced right after the most severe situation is finished. Finally there are instruments that are meant to operate when the worst situation prevails.

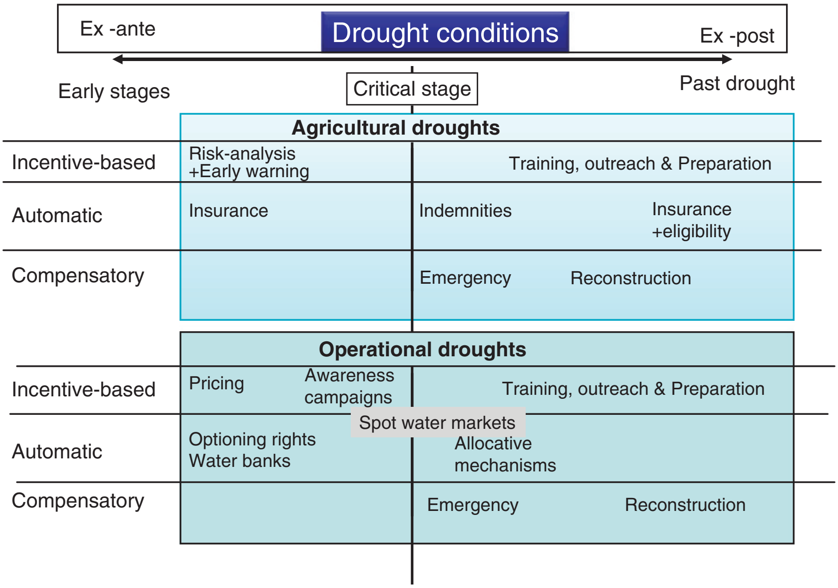

Fig. 10.1 Conceptual representation of economic instruments to face drought risks

We are aware of two limitations of this conceptual approach. First, there is uncertainty about the severity and duration of droughts, so no one can be sure about the precise stage in which a given situation is to be qualified. And yet, this uncertainty can be evaluated in terms of probabilities and likely effects. Secondly, the difference between ex –ante and ex –post approaches is equally ambiguous, because of the cyclical nature of droughts. With ex –post, we refer primarily to instruments that help prepare and convey learning messages about drought events. With ex –ante, we refer to instruments that reduce the vulnerability to droughts and lay down the institutional framework for the eventual practical application of risk-sharing mechanism.

There is another criterion to differentiate economic instruments. Figure 10.1 identifies ‘incentive-based’, ‘automatic’ and ‘compensatory’ instruments. Incentives are meant to send scarcity signals, promote technological change and in general reduce the physical water-base of society and the economy. Automatic instruments are those triggered by pre-established conditions and enable the exchange of risks, rights or services between agents whose livelihood, activity or well-being depend on water availability. Compensatory instruments provide relief or reconstruction payments or financial support to those affected by droughts.

Economic Instruments for Efficient Risk Sharing and Preparation for Droughts

Drought risks can be efficiently shared in the economy. Risk sharing includes numerous forms and strategies to distribute the burden of drought effects in the most effective manner. When risk-sharing instruments are in place, firms, entrepreneurs and even consumers can pursue their objectives knowing that they can transfer their risks to someone else or find coverage for those in the economy. Some of these risks can be handled by private markets or shared among the agents themselves, and some others would ultimately fall on the government. In a well-functioning economy, one in which markets react flexibly to the scarcity or abundance of goods, agents are more equipped to deal with many of the risks characterised by known probabilities. This is part of what economic instruments can contribute to more society preparation. And explains the tremendous difficulties of developing countries to face natural risks, such as droughts and other hazards.

With the conceptual framework sketched in Fig. 10.1 in mind, we now review the instruments that deserve more attention because of practical experience, literature findings and hypothesized potential.

Instruments to Cope with Meteorological and Agricultural Drought

Traditionally, farmers have developed some informal strategies to cope with weather risks by actions taken before (ex-ante) or after (ex-post) the risk event occurs. Those strategies include changing labour allocations, varying cropping practices, and conservation tillage that protect soil moisture. Recent experiences have demonstrated that these weather risk management strategies are costly and inefficient because they have important shortfalls resulting in negative implications for economic and social development (Hess et al., 2002, Anderson, 2006).

In developing countries, farmers have little access to credit markets and agricultural insurance. Private insurance markets and credit markets provide at best partial coverage but fail due to poor contract enforcement mechanisms, information asymmetries, high transaction costs and covariate risk exposure (Barnett et al., 2005). These market failures imply a limited scope for crop insurance, a low number of insurers, adverse selection of farmers that take up insurances and finally, moral hazard problems. The failure of formal and informal risk management mechanisms implies disadvantages to farmers in dealing with numerous other risk sources deriving from markets, policies and institutions implying high production costs (Siegel and Alwang, 1999). Even in developed countries, compensation for drought effects makes up a large proportion of the total ad-hoc and relief payments to farmers (European Commission, 2007). This suggests that more could be done to facilitate risk sharing or risk-transfer using privately developed instruments, instead of relying on taxpayers and government support.

Since early-warning systems and risk-analyses are covered in other chapters of this book, we focus on 'automatic instruments' and 'compensatory schemes'.

Crop insurance is the most obvious form of an automatic instrument. In general two types of farm insurance covering drought risks can be identified. The traditional family of insurance is defined by the coverage, crop conditions and a loss adjustment procedure. Yield losses due to insufficient soil moisture are thus indemnifiable. Losses are either evaluated for a given agricultural demarcation and applied as such to all subscribing farmers included, or determined in situ farm by farm. Spain and the US have experimented with this type of insurance for decades, with moderate success (Cafiero et al., 2005). In Spain, about 4 to 5 million hectares (45% of the eligible area) of winter cereals and other arable crops are insured against yield losses caused by droughts or other climatic effects.

More recently, new formats of drought insurance have been launched in a number of countries, both developed and developing. They are based on drought indices and are often referred to as 'parametric insurance'. Examples of these insurance schemes are Index-based risk transfer products (IBRTPs) or Weather Index Insurance (WRW, World Bank, Morocco). The common feature of both is that they are designed in a simpler contract than those required for yield insurance. The key innovation of such contracts is that the insurance is linked to the underlying systemic risk (i.e., low rainfall), defined as an index and recorded at a regional or local level. The insurance scheme transfers covariate risk out of the region or country into international financial markets, previous transforming weather risk into weather derivatives.

Wu and Wilhite (2004) have developed an operational model framework to assess agricultural drought risk by establishing a predictable relationship between some drought indices such us SPI or Crops Specifics Drought index and crop yields. This kind of modelling provides information in a timely manner about potential agricultural drought risk on dry land crop yields to decision makers ranging from agricultural producers to policy makers from local to national level. This operational model would be the basic framework for a formal contract based on weather risk markets which is able to offer yield assistance to farmers.

What has been named 'parametric' or 'index' insurance is just a one way of creating contracts that underlie the risk of experiencing long periods of low precipitation. A few countries, including Morocco and some Sub-Saharan countries, have developed insurance policies that operate as call option contracts. Others, including Spain, Canada, US and France developed 'vegetation index drought insurance' which pay indemnities if the index, based on remote sensing, falls below a certain level. The European Commission has evaluated the cost of setting up similar technologies for the EU as a whole, reaching figures within a reasonable range (European Commission, 2007).

Both parametric insurance based on accumulated precipitation and insurance based on vegetation indices have allowed France, Spain and the US to integrate in their drought planning a system that creates automatic triggers for compensation. The major appeal of such instruments is that a good part of those agents vulnerable to drought events can find protection against them. In the case of Spain or France, droughts account for the highest income losses that both countries can experience. In France, about 50% of the €75 mio./year paid by the *Fond Calamités* is related to drought costs (Garrido and Bielza, 2007). In the US, index insurance based on vegetation indices has been available on 40 mill acres since 2006. Its unique feature is that producers may choose to insure only those acres that are important to their grazing program or hay operation, and are not required to insure the acreage for the entire crop year. There have been a number of proposals in this line:

- Water table, rainfall and droughts in India (Agarwal, 2002).
- Rainfall indices in Morocco (Skees et al., 2001).
- Rainfall indices in Romania (Hou et al., 2004).

Compensatory schemes are generally ad-hoc relief programmes. In the EU, ad-hoc payments are more frequently used than any form of insurance to grant compensation to farmers (European Commission, 2007). Common avenues of compensation are tax relief, support for input substitution for livestock growers relying on pastures, and many diverse forms of financial support to eligible farmers. This book reviews some programmes as they are applied around the Mediterranean countries.

In countries where agricultural insurance is growing or fully established, eligibility for disaster assistance is increasingly being conditioned on having purchased at least basic coverage insurance. By these means, disaster assistance, no matter in what format it is delivered, is linked to pro-active measures which, in the case of France, increase the contributions to the disaster funds, via taxes. Furthermore, in France larger insurance coverage implies eligibility of greater aids in case of disaster resulting from non-insurable risks. In Spain, aids for farmers hit by severe droughts were conditioned on the commitment to purchase drought insurance for the following three years (Garrido and Bielza, 2007). In addition, in Spain risks for which insurance policies are offered cannot be compensated with ad-hoc relief funds. The European Union requires that, starting in 2010, farmers' eligibility to aid measures shall be conditioned on their contracting minimum coverages of crop insurance (EC, 2006).

Instruments to Cope and Prepare for Operational Droughts

Presently, the context in which water allocation evolves in the Mediterranean basins is characterized by overall scarcity and by increasingly uncertain availability. Even in highly controlled basins, many users are subject to considerable uncertainty regarding their water supply. In many Mediterranean basins, farmers' annual water allotment is highly variable so agricultural producers generally face some uncertainty about the final allotment (Calatrava and Garrido, 2005a, Iglesias et al., 2003). In the case of the urban sector, water supply reliability is one of the major worries of the urban water authorities. Actually, urban water utilities are designed to meet demand during drought records or the most severe actual hydrological event on record. Risk analysis and evaluation are becoming essential components at all levels of water management, from retail supply services to large-scale basin management (Hashimoto et al., 1982, Iglesias et al., 2006).

In contexts where there is large artificial and natural storage capacity, water scarcity risks are endogenous to management institutional and practical criteria. Actual demands and allocations have been shown to influence the chances of experience water shortages (Giansante et al., 2002, Lise et al., 2001). Just as we did with agricultural droughts, we turn to the economic instruments to cope and prepare for operational droughts.

We have identified four instruments in Fig. 10.1 under this category: ‘water pricing’, ‘awareness campaigns’, ‘spot water markets’ and ‘training, outreach and preparation’. The latter is covered in other chapters of this volume, so we will focus only on water pricing and markets. Note also that markets are centered on the borderline between the groups of incentive-based and automatic instruments.

Pricing Mechanisms

Pricing mechanisms can be used to address scarce water supplies. Municipal water utilities used to face drought conditions imposing a temporary drought surcharge to achieve conservation goals. Sometimes this surcharge is meant to recoup the costs of extraordinary measures put in place to respond to water scarcity. In the case of irrigation water management, there are many ways to address scarce water supplies by water pricing, like applying higher marginal cost prices during seasonal shortage to ration all the water demand. An efficient water pricing mechanism implies that prices would rise to reflect the relative scarcity value of water supply. But there are several limitations to apply marginal cost pricing related to difficulties in defining the marginal cost itself.

Water tariffs could be applied successfully in the long term but can be less effective for short-term demand reduction. In the first case, when a new water tariff is being designed, it must consider the cost of all water schemes (capital cost of dams and waterworks) and consequently the average cost of water to consumers. Also pricing schemes must consider the reliability of supply during drought in order to minimize the economic loss due to restrictions. Those imply that operational policy for reservoirs may be designed to enable water to be conserved during drought and, as a consequence must be internalized in the water tariff system. In the short-term drought management by means of tariffs raise problems of time lags. The establishment and promulgation of punitive tariffs to meet certain requirement may require months before the tariff is charged, detected and evaluated by consumers who will then change their consumption, but possibly not by the amount desired by the price. The use of a two-part tariff method can solve this problem as far as the scarcity cost is covered by a fixed charge and higher consumptions are penalized by a volumetric part. Quota allotments are often included in the volumetric part of the tariff by charging the water volume exceeding the amount of quota. In this way quota systems coordinated with water pricing systems avoid inequity issues (Rieu, 2006).

Awareness Campaigns

Evidence from several campaigns shows that awareness building can effectively reduce water demand. Seen from an economic point of view, campaigns are effective means to change the preferences of consumers and in turn their behavior. For example, in Saragossa (Spain) large water conservation awareness campaigns made it unnecessary to raise the level of reservoir as had been planned earlier.

Persuasion campaigns for demand management are mostly effective in times of drought or water shortages. There are many examples of improvement of drought exposure as a consequence of the awareness campaign. Canal de Isabel II, the water company, has reduced the water consumption in Madrid and surrounding cities (5.5 mill) by 10–12% at a cost in terms of media publicity of 15 million euro. The savings ratio may be in the range of 0.3 €/m^3, which is quite low considering the risk of entering into serious water shortage conditions. In these cases the immediate need is obvious and there is high motivation in the community to conserve water. However, the success of awareness campaigns depends on developing the persuasion model in a scientific and systematic way. Effective water conservation campaigns need to research behavioral change models systematically not only during drought periods (Syme et al., 2000).

Water Markets

Exchanges in water markets are widespread economic instruments that have been developed in the past decades in mature water economies (California, New Mexico, Australia, Spain, Chile . . .). But it has also been recognized that the effectiveness of water trading is explicitly influenced by various uncertainties existing in water use systems (Luo et al., 2007, Calatrava and Garrido, 2005b). This uncertain context implies that water markets exchanges among farmers usually take place when water allotments are known but the positioning of each exchanging party is partly subordinated to decisions taken under uncertainty (Calatrava and Garrido, 2005a). Also, water-trading effectiveness is sensitive to trading costs, the exchanges failing when the cost is too high (Easter et al., 1998, Luo et al., 2007). Trading costs are directly related with uncertainty of water available. However with sufficient training and practice, markets can become a commonly used instrument to face supply instability.

Reallocation of water resources through voluntary water markets generates substantial gains for economic agents especially when supply is reduced by the occurrence of drought. The purpose of reducing risk through water stabilization is better achieved through annual spot markets than permanent water rights. In the latter case, risk is being shared inefficiently between seller and buyer, who hold a riskier position, as he would need to acquire an unknown surplus of water during drought years. On the contrary annual spot markets allow for a more efficient distribution of supply risks among the exchanging parties.

Another important issue related with sharing risk by means of a water market is the definition of formal water trading rules. Calatrava and Garrido (2006) propose a redefinition of informal priority rights into formal water rights as a way to reward risk-taking water users and increase total collective output. In this context expectations that markets can emerge spontaneously from a decentralized negotiation process among farmers themselves may be too optimistic. In this sense the role of institutions like basin agencies is quite important in establishing criterion to distribute available resources among all right-members. As a consequence, water markets are allowed to work effectively and reliably, thus reducing society's drought vulnerability.

In contexts where the frequency of droughts augments, water markets may need other water policy requirements to ensure that water markets can effectively move water to higher value users during drought periods. Often it is necessary to develop optimal conditions to activate previously unused water entitlements. For Bjornlund and Rossini (2005), more sophisticated markets and instruments need to be developed to ensure that these constant redistributions of entitlements and seasonal allocations can take place quickly and at low transactions costs. For this aim, it is necessary to design a long-term, secure and well-defined water right, and ensure that land and water rights are kept separate. Some times it is even necessary to define rights for storage capacity. In this sense, Iglesias et al. (2003) recommend that, prior to establishing water markets which are complex institutions and not always very active, water institutions should begin by defining special types of water rights which promotes voluntary water saving across seasons. Irrigators facing uncertain water supplies would probably be interested in using the banking option as a strategic response to reduce their vulnerability to drought periods.

Risk-Sharing Instruments that Underlie Natural Supply Variations

The risk of suffering operational droughts can be shared or pooled together with other societal risks. However, designing feasible risk-sharing instruments for operational droughts is a challenging task. This is because water uses are generally inter-connected and there are numerous sources of externalities. It is thus difficult to isolate two water users that can share natural supply risks, following optioning rights or a similar format, without compromising other uses or in-stream services. Formal risk-sharing instruments require agreements to be formulated in such a manner that there might be little room for ambiguities or problems of enforcement. But this rigidity enables the contracting parts to plan ahead and evaluate the resulting risks more rigorously. Most treaties to manage transboundary water resources have these types of risk-sharing components. In Spain, the Tagus-Segura transfer is run with reference to the storage of key reservoirs that dictate when and how much can be transferred at any given time. But very often, political pressure is put on by decision makers to allow for the use of short reserves, as happened in Spain in 1993–95 (Giansante et al., 2002).

Allocation of water resources has to take into account that not only do users demand secure access to water but also a reliable access, that is, water supply reliability. This reliability is not equally valued or demanded by all users. This premise must be taken into account by water institutions in designing new instruments to allocate water resources. That means the water authorities' main objective is not only to assign water use in an efficient way but also the risk derived from uncertain availability of water resources. These instruments also must have the possibility to compensate water right holders when water reallocations are required. A common feature to all instruments analyzed in this section is that they introduce the concept of economic value of water depending on the timing, location and quantity of water demanded. In other words, any institutional program attempting to capture adequately the value of water must be flexible enough to adjust to a range of market conditions (Hurt, 2005).

Water Banks

Centralized water management instruments such as Water Banks diminish the uncertainty because the final equilibrium water price reflects water scarcity and influences irrigators' production decisions. Considering that farmers must take ex-ante decisions before knowing what their actual water allowance will be, markets regulated by water authorities such as water banks diminishes the uncertainty stemming from water availability because farmers may participate in a pre announced water bank. Water banks work effectively and reliably achieving not only a better water allocation but also more efficient tactical responses to face supply uncertainty (Calatrava and Garrido, 2005a).

Experience acquired from 1992 and 1992 Drought Emergency Water Bank in California bring us some lessons for the future development of drought water banks. Israel and Lund (1995) highlight the vital role of water authorities for future adoption and acceptance of water transfer in water management. Water authorities accelerate the use of water transfer, reduce risk and uncertainty involved in water transfer and reduce cost of implementing water transactions.

Success of water banks depends on the integration of water transfers with supply and demand management approaches included in water planning at river basin scale. Environmental, legal and third-party considerations are important in the development and implementation of water banks. For these aims drafting and enforcing binding contracts among various entities is required as well as protecting conserved water as it flows to downstream users (Hurt, 2005). In addition, an educational effort of the water authorities to inform potential buyers and sellers of water rights about the mechanism of water bank is necessary.

Optioning Rights

Supply uncertainty brings out the necessity to seek new allocation instruments that ensure equitable resource access which take into account risk aspects, incorporating them in the planning process (Gómez-Ramos and Garrido, 2004). It is necessary to develop contracts that are capable of transferring risk as a means for reducing social and economic exposure to drought cycles. They rely on the heterogeneous means of water users for coping with periods of water shortage. Coinciding with the requirements of water rights advanced by Bjornlund and Rossini (2005), an efficient risk sharing mechanism also requires greater flexibility in water rights transfer, so that only some of the risk-related attributes of the water rights can be transferred. Under uncertain water availability, elements such as access security under prefixed conditions or the timely access to acquire scarce resources are essential attributes to plan demands and available resources in risk contexts.

An Option Contract can become an appropriate new instrument to facilitate this kind of exchanges based on specific rights' attributes. Their properties ensure efficient sharing of the risks associated with supply and the market price resulting from exchanges between common users – such as the irrigation sector – and potential water buyers – such as urban suppliers. As a result of these attributes' exchanges, water markets become more active and efficient.

Option Contracts can be the optimal framework to develop a formal long term arrangement that allows urban water authorities to control water rights just to suffice during normal years and to buy additional water allocations during periods of scarcity avoiding high transaction costs due to the necessity to buy in the "greed-of-the-moment" when the authorities have to 'panic' buy and the sellers are at an advantage (Bjornlund, 2006). The main drawback is that contracts must account for and detail all eventualities, and the valuation for both parties may become quite complex. For example, external prerequisites associated with the fulfillment of ecological flows in sensitive river tracts may be added to the contract's provisions to reduce third party or environmental effects.

Other Automatic Instruments

A number of studies have proposed the use of derivatives to handle water supply availability, but there are very few real case examples. Rainfall indexes are suggested as proxy to water storage and availability for irrigation in Australia proposed by Skees and Zeuli (1999). Flow derivatives in Mexico are suggested to control for water supply risks by Leiva and Skees 2005.

Putting Economic Drought Instruments into Practice

Many of the instruments reviewed have not inspired practical applications. For one thing, this reflects the daunting task of implementing them in a predictable and reliable manner. Also, it attests for the ironic fact that, although economics is the science of dealing with scarce goods, droughts are not easy handled by economic instruments, however rational it may seem from an academic standpoint. And yet, technology developments and applications enable agencies to have a closer look on how land and water is being used at given moment. Transactions costs of any of the instruments reviewed above have been lowered to the extent that they are now more cost-effective than letting droughts onset freely.

The literature and the world wide web offers plenty of experiences and evaluations. In this section we evaluate each instrument based on the requirements needed to be applicable and on the balance of advantages and disadvantages.

Agricultural and Meteorological Droughts

Table 10.2 includes the set of economic instruments meant to address agricultural and meteorological droughts. In the final column we add a score indicating whether the instrument's conclusions are robustly based on the available experience and the literature. The main conclusions that emerge from the table can be summarised in the following points:

Yield insurance, as the result of gradual improvements of multiple-peril crop insurance, can be expanded to cover yield losses caused by droughts and other hazards. Yet loss adjustment costs increase substantially the administrative loading of the premia. It is safe to conclude from the literature that, in the absence of subsidies, yield insurance could hardly be profitable. Yield insurance is popular among cereal farmers because they receive indemnities when yield losses occur. Refinements in Spain, US and Canada, and new initiatives in France, show that costs can be reduced when long farmers' records enable insurers to charge the right premium.

The alternative to yield insurance is 'parametric' or 'index' insurance, which is much cheaper to set up and administer. Parametric insurance provides coverage to crops with yields strongly correlated with simple precipitation indices. Based on the initiatives in US, Spain, and France, and experimentally in Ukraine and South Africa, vegetation indices computed from satellite images are used to offer commercial insurance to livestock growers relying on rangeland pastures. Other crops, like fruit, horticultural and even broad field crops are insufficiently covered with parametric insurance, which in turn reduces its appealing to farmers. When precipitation indices are essential for ensuring sufficient food production in developing counties, parametric insurance could be used by donors and FAO to protect against budgetary outlays connected to food security emergencies. Local or regional governments could also use this type insurance to provide financial assistance to the most vulnerable communities.

Compensatory schemes and relief programmes are often used in developed and developing countries. Generally, they are triggered only in cases of severe droughts. Buying insurance is now a prerequisite to become eligible for catastrophic relief in France. Spain precludes drought relief to farmers whose crops are insurable against drought hazards. The EU requires contracting insurance for aid given to farmers after 2010. These examples reflect that ad-hoc payments are difficult to administer, opting to subsidise yield insurance. Innes (2003) shows that ex-ante risk reduction policies can deter farmers that will eventually be in need of ex-post alleviation measures. He goes on to suggest that it would be efficient for governments to pay the riskiest subsidized farmers to finish their operations.

Table 10.2 Economic instruments for agricultural and meteorological droughts

Instrument	Requirements			Advantages	Disadvantages	Robustness/ Reliability of conclusions
	Legal/ institutional	Technological	Economic			
Yield insurance	Sound insurance regulations Private participation	Long records of farmers Loss adjustment procedures	Willingness to pay expensive premia (Doubtful without subsidies)	Protects against drought losses No basis risk	High loading factor Expensive loss adjustment Prone to adverse selection Administrative demanding Very few crops are insurable	Very robust (long experience) Spain and US
Parametric insurance (based on precipitation indices and vegetation indices)	Sound insurance & commercial regulations	Needs long precipitation records Dense meteorological stations Data handling and servicing Challenging for satellite systems	Definition of contracts Out-reach and extension services	Cheap to administer No asymmetric information Fixed and simple premium	Large basis risk Lack of farmers' understanding	Still in early stages: Based on remote sensing and vegetation indices in Spain, France and US Experimentally in Ukraine & South Africa Functioning in Morocco Proposed in India and Mexico
Compensatory schemes and relief programmes	Ad-hoc legislation and calamities programmes	Evaluation techniques and data recording	Need ad-hoc relief funds Limited access to financial markets	Helps business recovery Allows for targeting groups	Moral hazard Slow reaction processes Very bureaucratic Entirely based on governmental budgets	Very robust

Hydrological and Operational Droughts

Many studies have attempted to analyse and compare the suitability of economic instruments based on economic efficient criteria, on effects on third-party and the environment and also considering risk management ability. But this section also tries to afford this task considering the requirements and limitations for its implementation valuing the capacity to allocate water supply reliability. Table 10.3 summarizes the main findings and lessons with regards to the instruments reviewed earlier.

Water prices may reflect water scarcity values but they can hardly reflect the value of supply reliability. In general, water tariffs are not able to convey information about the uncertainty dimension of supply reliability. However, water tariffs indirectly increase water supply reliability, because they provide incentives for self-restraint and more frugal consumption. This adjustment is achieved further if water tariffs are accompanied by awareness campaigns and educational efforts. In this way, applying a water tariff system under ex-ante drought management criteria diminishes drought risks in the long run. In short, water pricing is a robust long-term policy to reduce scarcity risks, but it is not sufficiently flexible to face shortage situations.

Quotas and other rationing mechanisms can avoid inequity problems derived from exclusion of the systems of low-income groups that require at the same time similar levels of reliability as other economic agents. Direct public intervention in allocating scarce resources is fully justified when basic human needs are threatened, or the probability of experiencing such situation goes beyond certain thresholds. We do not advocate the use of economic instruments under such conditions.

Awareness campaigns are necessary instruments not only during drought periods. An effective campaign must be persistent in time because in this way it is able to change consumers' behaviour and preferences. For this aim, it needs systematically monitoring of behavioural change models. Awareness campaigns do not only seek to reduce consumption but also to increase citizens' concern about the value of resources as public goods.

Water markets need sound regulatory frameworks, broad acceptance and transparency to ensure that exchanges occur frictionless. Everyone must accept that during shortages prices can skyrocket, choking the demand of non-competitive bidders. If this situation is to be avoided, market bounds and limits must be pre-announced beforehand. But then rationing mechanisms would eventually become unavoidable, encumbering right-holders that may have hoarded resources to sell them at high prices.

Part of the problems of completely liberalised allocation mechanisms can be overcome with centralized water management instruments like Water Banks. With sufficient learning and experience, water banks may become a real risk management instrument, creating an automatic response triggered by pre-established conditions captured by the regulatory framework. These exchange mechanisms may assist basin authorities to reallocate water resources, to create awareness of the resource cost and to reduce drought effects. The main challenge of Water Banks is to adjust water demand and supply in a timely manner, facilitating water exchanges. As publicly run water banks can easily be monitored and scrutinised, they are more transparent and enjoy greater acceptance.

Table 10.3 Economic instruments for operational/hydrological droughts

Instrument	Requirements			Advantages	Disadvantages	Robustness/ reliability of conclusions
	Legal/ institutional	Technological	Economic			
Water tariffs (including punitive tariffs)	Water law and pricing policies Water rights	Metering devices	Capacity to pay	Incentives to save water Lower basins' demand	Insufficient to face water shortages Not flexible enough to approach market clearing prices Not applicable for groundwater	Very robust
Quota allotment	Enforced water rights Implementation bodies and decisions processes	Metering devices	Sometimes includes compensatory packages	Based on statutes Taken by public agencies Users' participation Sense of equity Easy to prioritise	Inflexibility Economic inefficiency Inadequate to reward risk taking and more valuable crops Poor as a risk management instrument	Very robust
Water shortage awareness campaigns	A well defined set of agencies' responsibilities	Adequate sociological expertise	Availability of funds	Lower consumption Increases awareness Changes preferences	Low persistency effects Low savings per €of expenditure	Varies across case studies
Spot water markets	Water rights Market regulation Reliable institutions	Transportation, storage and conveyance facilities Metering devices	Ability to create and distribute market signals Mature water economies Needs proper water tariffs on the 1st place	Demand and supply equilibrium Market clearing prices Market as a risk management instrument	Transaction costs Third-party effects and externalities Misalignment with social/ environmental priorities Not popular among farmers Not very liquid/ active	Robust
Water banks/ optioning rights	Same as spot water markets, plus Ad-hoc agency to run/ monitor exchanges	Storage and conveyance facilities	Preparation Understanding rules by agents Mature water economies	Good risk management instrument Can be combined with optioning rights Agencies set prices or market rules	Institutionally demanding Needs storage Potentially thin	Based on very few examples

Option contracts, be they connected or unconnected with water banks, can facilitate the transfer of water rights in prearranged terms, before drought periods begin. This is an efficient way to transfer supply risks, because it is not necessarily accompanied with actual water exchanges. Gómez-Ramos and Garrido (2004) and Michelsen and Young (1993), among others, show that option contracts are much more efficient than erecting new dams to add more supply stability. Both option contracts and water banks are capable to transfer risk as a means for reducing social and economic exposure to droughts.

Conclusions and Practical Lessons

Droughts have many social implications, some in the public domain and some manifested at the household and firm level. Economic instruments are meant to reduce the probability of experiencing shortages, increase the efficiency of resource allocation and enable risk-transfer mechanisms that increase social welfare. This chapter has reviewed some of the most commonly used economic instruments applied to manage both agricultural and operational droughts.

Three main conclusions summarise this chapter. First, drought risks can be defined in such a manner that allows for the development of contracts that enable risk transfer in the economy. This principle can be applicable both in ideal conditions and suboptimal conditions. More information, technology, data and degree of law enforcement just makes the multiplication of contract options and market activity easier. In their absence, countries and regions can still develop simpler instruments that can transfer the most crucial risks to agents that can handle them (the State could be one). When agents, households and firms can buy risk protection at a reasonable cost, society and the economy win. Drought insurance and optioning rights are the best examples to find inspiration for policy action and research.

Second, droughts have public good consequences that predicate government action, no matter how inefficient command and control and public allocation may seem. Meeting households' basic needs, protecting essential ecosystems and ensuring minimum levels of economic activity should be top public priorities. By no means does this second conclusion contradict the first. They reinforce each other to the extent that these key objectives can be partly accomplished by a well-functioning market economy.

Third, all economic instruments can be placed along an imaginary discretionary-automatic axis. Discretion generally requires flexibility but cannot avoid the costs of improvisation. At the policy level, targeting will be difficult and rent seeking may erode the efficiency of transfer of support. Automatic instruments are triggered by objectively measured means and reach the target much quicker. Conditions or prerequisites can be embedded in them, allowing for better screening and more accurate targeting. Yet combating drought risks needs discretionary as well as automatic instruments.

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