# NATIONAL REGULATIONS FOR GROUNDWATER: OPTIONS, ISSUES AND BEST PRACTICES

**by**

**Stefano Burchi**
**FAO Development Law Service**

*FAO LEGAL PAPERS ONLINE #5*

*August 1999*

FAO Legal Papers Online is a series of articles and reports on legal issues of contemporary interest in the areas of food policy, agriculture, rural development, biodiversity, environment and natural resource management.

Legal Papers Online are available at http://www.fao.org/Legal/default.htm, or by opening the FAO homepage at http://www.fao.org/, and following the links to the FAO Legal Office Legal Studies page. For those without web access, email or paper copies of Legal Papers Online may be requested from the FAO Legal Office, FAO, 00100, Rome, Italy, dev-law@fao.org. Readers are encouraged to send any comments or reactions they may have regarding a Legal Paper Online to the same address.

# NATIONAL REGULATIONS FOR GROUNDWATER: OPTIONS, ISSUES AND BEST PRACTICES

Stefano Burchi, Senior Legal Officer
Development Law Service
FAO, Rome[1]

## 1. Introduction

Groundwater is in general a high-value resource and is especially important as a source of drinking water. In Europe, for instance, 75 percent of drinking water supplies comes from groundwater sources, with peaks of up to 98 percent in Denmark. In the United States, groundwater is the source of approximately 50 percent of all drinking water, and 97 percent of that used by the rural population. Although in many countries the most important use of groundwater is for drinking water supply, in other countries or regions other uses may dominate. In Australia, for instance, groundwater accounts for only 14 percent of water use. However, it is an important source of irrigation water and as a water supply for livestock. In India, 50 percent of the water which is used in irrigation comes from under the ground. Groundwater is also important in maintaining the flow of rivers (known in hydrologic parlance as "base flow") in dry periods and in contributing to the water balance of lakes and wetlands.

The sustainable management and use of groundwater resources as a source of drinking water supplies, for irrigation and for other consumptive uses as well as a supplementary source of surface river flows and of wetlands and wildlife habitats calls for increasing attention to two major and interdependent sources of concern, namely, depletion and pollution. The former is linked to the extraction and use of groundwater, the latter to the contamination of available groundwater supplies from point and non-point (or diffuse) sources. To the extent that either or both (depletion and pollution) threaten the long-term viability of available supplies and the sustainability of their development and use and may become, as a result, the source of social tension and conflict, the legal systems have been prompted to respond with a view to defusing such tension and the potential for conflict. National regulation of groundwater extraction and use and of polluting activities has largely - but not entirely - supplanted private legal remedies available to injured plaintiffs. The comparative review and analysis of available national groundwater legislation illustrate the choice of mechanisms - regulatory and otherwise -, or options, available to the lawmakers in the framing of responses to the challenges posed by groundwater depletion and pollution. The same review and analysis show at the same time emerging trends or crystallization of best practice

[1] This paper was prepared for the World Bank Seminar on *Groundwater: Legal and Policy Perspectives*, Washington D.C., 19 April 1999, and is expected to be included in the published proceedings of that Seminar. The opinions expressed are the author's and do not engage or purport to engage the Organization.

approaches, and disclose the issues which available options and emerging best practices raise.

This paper will review and analyze national legislation believed to be representative of the available choice of mechanisms or options and illustrative of emerging best practices and attendant issues. It is worth noting that the countries whose legislation has been reviewed for the purposes of this paper are representative of a variety of climates - from humid England to arid Niger - and of different legal systems, notably, common law and civil law.

## 2. Regulation of well drilling and of groundwater extraction

### 2.1. Private ownership of groundwater

Traditionally and in accordance with basic principles of Roman law, groundwater has been regarded at law as the property of the owner of the land above. Countries following the Napoleonic Code tradition, as well as countries following the Anglo-Saxon Common law tradition, equally subscribe to the same principle. The Moslem tradition, instead, regards water as a public or communal commodity, a gift of God which cannot be owned. Only wells can be owned, whereby exclusive or priority user rights in the water accrue to the well-owners. Furthermore, the ownership of wells entails ownership of an area around the well in which new wells cannot be dug (known as *harim*, or forbidden area).

Private ownership of land and of groundwater under it entails the accrual of un-restricted enjoyment and user rights, including the right to prospect on one's land for the resource, and to extract and use it, limited only by the equal rights of the neighbouring landowners. If conflicts erupt between adjoining landowners, the disputes are settled through formal and informal mechanisms, notably in the courts of law. Inasmuch as they apparently are meant to react to conflict, these traditional rules of groundwater ownership and use are increasingly at odds with the growing pressure on finite and fragile stocks of resources brought about by the growing demand for good-quality water from competing sectors of economic and social development and well-being. To make matters more worrisome, ever more sophisticated, potentially destructive drilling and extractive technologies have become available. Already in reaction to these threats, the American courts tried to put some fetters on the landowners' un-restricted groundwater withdrawal privileges by imposing a reasonableness requirement on groundwater extraction and use. Under the rule, the landowner is only entitled to use as much water as can be reasonably consumed on the overlying lands. Waste of water and use on non-overlying lands is prohibited. Still, the doctrine allows landowners to withdraw and use groundwater in whatever quantities they need for reasonable and beneficial purposes until the underlying groundwater supply is exhausted. It does not restrict the landowner to the use of a particular quantity of water nor does it guarantee the landowner that the

groundwater supply under his land will be preserved from depletion by the withdrawals of others.

### 2.2. From private ownership to regulation: scope of regulation

The challenge nowadays is to prevent expensive and time-consuming conflict or to minimize opportunities for it and, at the same time, to ensure that groundwater reserves are (a) directed to the uses society - or the public - value the most and (b) conserved for future use. In response to this challenge, legal systems, particularly but not exclusively in water-short countries, have increasingly brought the digging and drilling of boreholes, the construction of wells and the extraction and use of groundwater resources under the direct control of the Government. As a result, if one wants to dig or drill bores to prospect under one's own land - or under somebody else's land - for groundwater, the Government must be first approached and a permit or authorization obtained from it, subject to terms and conditions. Groundwater pumping tests may also attract separate permit or consent requirements, as under the legislation of England and Wales.[2] Equally if, following successful tests, one wants to construct a well and put it into production and start extracting and using groundwater, the Government must be first approached and a permit, licence, concession or the like instrument obtained from it, subject to terms and conditions.

For ease of administration, regulatory restrictions and requirements tend to be relaxed in relation to the digging of bores and wells by hand and/or up to a maximum depth, and to the extraction and use of groundwater not exceeding certain volumes and/or for the abstractor's domestic and other household needs. The relaxation can consist of a total waiver of permit or other similar requirements (under the legislation of England and Wales, domestic abstractors of groundwater extracting up to 20 cubic metres per day are totally exempted from licencing requirements, with thought being given to extending the waiver to extractions for any purpose). Under the recently (end 1998) amended legislation of Niger, the extraction of groundwater for whatever purpose of use attracts simpler "declaration" requirements if the volumes which are extracted do not exceed 40 cubic metres per day.

### 2.3. Follows: the transition from private ownership to regulation

The governmental assertion of control of groundwater prospection, extraction and use rests on the public property status accruing to groundwater from the statutory vesting of the resource in the public domain of the State (this is the approach reflected in the legislation adopted in Spain and in Italy, respectively, in 1985 and in 1994); or from the statutory vesting in the State of superior user rights (this is the approach followed by the state of Victoria (Australia) as reflected in the Water Act of 1989); or from the statutory vesting in the State of a public trust in the resources on behalf of the people, as

[2] The dewatering of quarries tends also to attract regulatory requirements. Requirements to this effect have been proposed for introduction in the legislation of England and Wales.

reflected in South Africa's 1998 National Water Act; or from the pronouncements of the courts of law, as with the "public trust" doctrine developed by the courts in the Western United States after the declaration of the Supreme Court that the land underlying navigable waters is owned by the states. A critical issue arising in this connection is whether the former owners of groundwater are entitled to compensation from the Government for what could be construed as a taking of constitutionally protected private property rights. Court challenges on these grounds have been experienced in Arizona and New Mexico (United States) and in Spain, in reaction to legislation which vested all groundwater resources in the State and divested landowners and well owners of private ownership rights in groundwater. The challenges and the attendant compensation claims, however, have been consistently rejected by the United States courts and by the Spanish Supreme Constitutional Court alike, and the new legislation upheld, essentially on the grounds that such vesting was justified by the superior common good pursued by the legislation and that reasonable mitigating measures had been provided for in the legislation to mitigate the impact of the vesting provisions on landowners and well owners.

As a result of groundwater being public property - or being held by the State in trust for the public -, only user (or usufructuary-type) rights accrue to the owners of overlying land - or to the developers of the resource, if other than the landowners. Such rights are granted by Government (sometimes by the courts, as in some Western states of the United States), following appraisal by Government of an application, and subject to terms and conditions. Among these, terms and conditions as to the duration of the right and as to the quantity and rate of extraction play a critical role in regulating groundwater use. Of note in regard to the former, Iowa (United States) legislation restricts the duration of groundwater extraction permits to less than ten years if the aquifer capacity is uncertain. Of note in regard to terms and conditions regarding extraction, Arizona's (United States) groundwater regulator affirmatively limits the amount of groundwater which can be used by each class of water user. Furthermore, that state's legislation sets the maximum *water duty* or allotment on each farm, based upon the crops historically grown and assuming increasingly stringent measures for the efficient application of irrigation water such as lining irrigation canals and using laser leveling fields[3].

Groundwater rights obtained from the Government (or from the courts) are granted subject to loss for non-use of the water, for failure to comply with the law in general and with the terms and conditions attached to the right in particular, or if the water needs to be re-allocated to some other use and to another user. In this particular case, however, compensation is payable to the user who is dispossessed of his water right - through no fault of his. Rights are also subject to review, and to variation or adjustment downwards by Government if the circumstances so warrant. Also in this

[3] The Groundwater Management Act, 1980, contains a further provision that beginning twenty years after enactment of the Act in 1980, the Department of Water Resources may reduce the highest 25 percent of water duties by up to 10 percent.

case, compensation is payable to the user on account of the diminution suffered in his right.[4] Rights can also be suspended as a penalty for non-compliance, or in emergencies, in neither circumstance compensation being payable for the damage the right holder may suffer.

The appraisal of an application for the grant of a groundwater extraction permit or the like instrument plays a critical role in the informed allocation by Government of available groundwater resources. The determinations of water resources plans, if available (see below), and the views and objections of affected water users and of other legitimate affected interests, will provide valuable parameters for the appraisal of applications - in addition, of course, to the data and information on record. Increasing recourse is also being made in this regard to formal Environmental Impact Assessment (EIA) requirements of applications. Under European Union legislation (Directive) adopted in 1997, from March 1999 an EIA will be required of all proposed groundwater extractions giving rise to significant environmental effects as defined in the relevant Directive. Similar requirements had been introduced in France by the 1992 Water Act in respect of water abstraction projects in general, and are being contemplated, also in regard to water abstraction projects in general, in Spain under the guise of amendments to the 1985 Water Act.

Recourse from Government's decisions on applications and on existing permits is generally available before the courts of law or the Government itself.

### 2.5. Regulation of groundwater "mining"

Where the circumstances of groundwater extraction and use result in the accelerated depletion of the resource - known also as groundwater "mining" - the legal systems tend to respond through legislation providing for the establishment of control areas or districts where stricter regulatory restrictions become applicable or where the mechanisms described above, un-available elsewhere on account of paramount constitutional limitations, become available inside the declared areas or districts. In Texas (United States), for instance, permitting, well spacing and setting extraction limits, all un-available in principle due to that state's subscribing to the rule of private ownership of water by the owner of the land above, become available inside areas which have been declared Groundwater Conservation Districts. Restrictions, however, are not mandatory as most of the districts which have been established have worked to get landowners to implement conservation measures voluntarily through educational programmes and by providing data on available supply, annual withdrawals, recharge, soil conditions, and waste. In Wyoming (United States), where groundwater extraction and use are governed by prior appropriation, "control areas" can be established where

[4] This principle, sanctioned by the 1991 Water Resources Act of England and Wales, has been the subject of a recent non-judicial test involving the Government-initiated downwards variation of a groundwater extraction license which was threatening the ecology of a river. In the event, however, the test did not address the issue of compensation.

new applications for new groundwater extraction permits are no longer granted as a matter of course, but may be approved only after surviving a string of tests, hearings and reviews. The control area mechanism is provided for by the legislation in force in the majority of the Western states of the United States. In Spain, among several other amendments to the 1985 Water Act the Government is contemplating, one in particular provides for the declaration by the competent River Basin Authority of groundwater mining areas wherein (a) the Authority may restrict groundwater extractions until (b) a plan for the recovery of the aquifer is made and adopted. The plan will regulate groundwater extraction, including the replacement of individual extractions and of the relevant rights for a "communal" extraction and right.

### 2.6. Regulation of the well drilling trade

In addition and as a complement to the digging and/or drilling of bores, the construction of wells and the extraction and use of groundwater, also the exercise of the trade of well-driller tend to attract regulatory restrictions meant to scrutinize the professional competency of the individuals performing well drilling operations. This is so in most Western states of the United States[5], in Kenya, in The Philippines, in Oman, in Jamaica. With a view to strengthening the provisions laying down professional licensing requirements for well drillers, New Mexico (United States) legislation[6] requires one to contract with duly licensed drillers only.

## 3. Charging for groundwater extraction and use

Charging for water abstraction in general, and for the extraction of groundwater in particular, seeks to influence the demand for water and constitutes the chief non-regulatory mechanism available to control water abstraction and use. It is generally practised in combination with the regulatory mechanisms described above. In Belgium, charges are levied on the extraction of groundwater for purposes other than drinking water, with the revenue accruing to a fund for the protection of groundwaters. Belgium is one of the few countries that makes no differentiation in the charge level according to the type of use: still, the charge varies according to the volume extracted. In France, water abstraction charges vary according to volume, area, location and source - with groundwater extraction being charged at 2 to 3.5 times higher than surface water abstractions. Also in Germany charge rates vary according to use and tend to be higher for groundwater extraction. In The Netherlands, a groundwater extraction charging mechanism has been in effect since 1995, with the revenue used in part to fund

[5] Such as New Mexico, where it is unlawful to drill a well without a license and the State Engineer is empowered to determine the necessary qualifications for the grant of a license.

[6] In the United States in general,, regulations qualifying the exercise of the trade of well driller, and regulations making it unlawful for a contractor to contract with an unlicensed well driller, have been upheld as a legitimate exercise of the police power of Government.

research into developing groundwater policy plans and the remainder paid to the Finance Ministry as part of general taxation. In England and Wales, no charges are levied on groundwater extractions of 20 cubic metres a day or less for agricultural purposes. All other groundwater extractions are charged and the proceeds from all water abstraction charges are used to cover the costs to the Government of performing its function of water custodian. The levels and rates of charges are set accordingly and ostensibly do not seek to influence the behaviour of water abstractors. In the state of Arizona (United States), a tax is levied on all users of groundwater according to the volume which is consumed. The proceeds from this tax are directed to purchasing existing water rights and retiring them from use, to conducting water augmentation programmes and to sponsoring research on water conservation.

## 4. Controlling pollution of groundwater

### 4.1. From private law remedies to statutory law

Historically, private remedies have been utilized to address water pollution in general, and groundwater pollution in particular. Tort concepts involving negligence, nuisance and strict liability have been resorted to by injured plaintiffs, in Common law and Civil law countries alike, to seek compensation for the damages suffered as a result of groundwater contamination. These remedies continue to play a role in providing redress for groundwater pollution. However, they are available only after pollution has occurred, and their successful fruition by injured plaintiffs is not without difficulty. Furthermore, it is very difficult to clean up an aquifer once it is polluted. Because of this and also of the proliferation of the sources of pollution and of their heightened pollutive potential, the legal systems virtually everywhere have been emphasizing the prevention of new pollution and the gradual abatement of existing pollution through the enactment of water pollution control legislation. With specific regard to groundwater pollution, the available legislation tends to reflect any one or any combination of the following approaches: (a) regulation of the discharging of wastewater and other wastes on and under the ground, (b) charging for these same activities and/or (c) regulation of land use. The first two are used in connection with pollution of groundwater from "point"-type sources of pollution, notably industrial outfalls and the outfalls of municipal sewerage systems. The third approach has been resorted to to address the "diffuse" pollution from underground storage facilities and from above-ground waste dumps and landfills, and to address pollution from "diffuse"-type sources, notably the runoff and drainage of pesticides- and fertilizer-laden cultivated land.

### 4.2. Prevention and abatement of point-source pollution

Government permits, licences or authorizations to discharge wastes on or under the ground, including into groundwater aquifers, subject to terms and conditions as to, notably, the composition and quality of the effluent being discharged and the treatment required prior to it being discharged are the hallmark of most regulatory legislation in

effect. However, direct discharges into groundwaters can be forbidden outright, particularly if the discharge involves dangerous substances. A two-track system combining permits and strict prohibitions has been adopted already in 1979 by the European Union, with mandatory effect on all Union member countries. Belgium, however, has gone further and banned altogether all direct discharges into groundwaters.

### 4.3. Prevention and abatement of diffuse pollution

Admittedly, the most insidious threat to groundwater, particularly in the long run, comes from the leakage and percolation under the ground of substances stored or handled in factories, other facilities, waste dumps or landfills; and from percolation under the ground of the runoff and drainage of cropland carrying pesticides and fertilizers. The former threat tends to attract licencing and monitoring requirements in respect of the siting of waste dumps (as, for example, under a statute adopted to this specific effect already in 1982 by Italy). A contemporary statute adopted by the Swiss Confederation restricts the siting, construction and operation of designated facilities handling liquid substances which may adversely affect water resources in general. Under such statute, the Cantons (or states of the Swiss Confederation) are to zone their respective territory into four different classes of water protection areas, calling for restrictions of increasing severity. In more recent times, under a statute - technically, an amendment to the 1959 Water Rights Act - adopted in 1997 by Austria, most landfills will require a permit under the 1959 Act. The operator must provide adequate security, in particular he must provide for future precautionary measures. If the precautions taken prove insufficient the Government may impose additional or other requirements. In extreme cases, the disposal of waste can be suspended temporarily or the landfill can be even closed. Furthermore, the Government may appoint a monitoring body at the expense of the licence holder. This (the licence holder) must submit annual reports indicating the type, quantity and origin of wastes deposited in the preceding year and the results of his monitoring programme. In Spain, among several other amendments to the 1985 Water Act being contemplated by the Government, the River Basin Authorities would be empowered to declare an area experiencing groundwater pollution or the risk of it as a "protected aquifer area". In such areas, the Authority's prior consent will be required of the siting of facilities, the extraction of inert materials or any other activity potentially impairing the quality of the water underground.

Cultivation practices have been increasingly attracting regulatory restrictions aimed at preventing, abating or minimizing pollution of groundwater from, in particular, nitrates employed in agriculture. At the end of 1991 the European Union has adopted legislation directing member States to designate nitrate-sensitive (or nitrate-vulnerable) areas[7] and to draw up a code or codes of "good agricultural practice". Within the

[7] The Netherlands, Denmark and Germany have opted for the whole of their territories to be subject to the mandatory controls specified in the Union legislation. In France, about one-third of the country has been classified as Nitrate Vulnerable Zone. According to some commentators, the United Kingdom has taken a more conservative approach and a much smaller area of the country than anticipated has been designated

designated areas, the provisions of such code or codes become mandatory for the affected farmers. A delicate issue, raised by the farming community in England and Wales, has recently arisen in connection with the designation of nitrate-vulnerable areas. In a challenge before the courts of law to the designation of specific areas under the Union legislation, the farmers plaintiff have contended that it is unlawful for the Government to designate an area wherein non-agricultural sources contribute to pollution from nitrates. The case is significant in that it raises two fundamental issues of environmental protection law as this has evolved in the last twenty-five years, namely, (a) the legitimacy of precautionary measures taken in conditions of scientific uncertainty; and (b) the causation link and the proper relationship between environmental protection and economic - in this case, farming - interests. In the event, the court declined to rule on the issue as it hinged on the interpretation of Union legislation and referred it to the European Court of Justice.

Outside the European Union, the application of animal manure is strictly regulated by statute in, for instance, Estonia.

## 5. Other mechanisms and approaches for the controlled development and use of groundwater and for their protection from pollution

### 5.1. Planning

In response to the growing concern for the long-term viability of available water resources, countries around the globe have been resorting to planning as a preferred mechanism for informed, forward-looking and participatory decisionmaking in regard to the management and development of water resources in general, including their protection from pollution. While the legislation regulating the water resources planning process does not provide separately for groundwater planning, the aquifer can be singled out as the basic ambit of groundwater planning, on a par with the hydrographic basin. This is so in France, for instance, where the 1992 Water Act introduced and regulated a complex water resources planning system based on General Water Plans (S*chémas directeurs d'aménagement et de gestion des eaux: SDAGE*) covering one or more basins, and on Detailed Water Plans (*Schémas d'aménagement et de gestion des eaux: SAGE*) covering one or more sub-basins or an aquifer. With specific regard to the latter, a number of *SAGE*s are under preparation, covering designated aquifers. The aim of these instruments in preparation is, in general, the reservation of good-quality groundwater to the satisfaction of the drinking water needs of the population, or the apportionment of the available groundwater to the competing user groups on a quota basis. A distinctive feature of the French water planning system is the participation of civil society in the formation and adoption of the plans. Another salient feature is the binding effect of planning determinations on governmental water abstraction and

---

pursuant to the Union legislation.

groundwater extraction permitting. In other words, if a groundwater extraction permit is granted by Government which is at variance with the determinations of a *SAGE* or also of a *SDAGE*, it can be challenged in the courts of law and quashed. This has actually been done in connection with the grant of a permit for the extraction of groundwater for industrial use from an aquifer which the relevant *SDAGE* (for the Seine-Normandie region) had reserved for drinking water use. The decision was quashed by the court and the permit withdrawn. As a French commentator has put it, the planning instruments available under the French legislation constitute the "best tool for the conservation and protection of aquifers which is available under French law". Also in Texas (United States), legislation passed in 1997 instituted a complex water planning system at regional and at the state level and gave the planning determinations a binding effect which they did not use to have under previous legislation. As a result, actions by, among others, the Groundwater Conservation Districts must conform to the adopted plans. However, as noted earlier, the regulatory authority of such Districts - and of Government outside such Districts- in relation to groundwater extraction and use is severely restricted by the prevailing Common law rule of capture. As a result, the impact of planning determinations on the allocative decisions made by the landowners is speculative at best.

### 5.2. Users' participation in decisionmaking

The participation of concerned water users in the making of decisions which affect them is widely seen and practised as an effective vehicle to build support for, and eventual compliance with, unpopular decisions. The water resources planning mechanisms and processes briefly recalled above all provide ample opportunities for water users' participation in the formation and adoption of plans, directly and through their elected representatives to the committees tasked accordingly. Under the 1997 Texas (United States) legislation, Regional Water Planning Groups consisting of, among others, representatives of a wide variety of water users' categories, are to prepare and submit to the state Government a Regional Water Plan for their area. In the French water planning system, the *SAGE*s are formed and adopted by an *ad hoc* Local Water Commission one-fourth of whose members consist of representatives of water users. Water users participate also in the adoption of the *SDAGE*s through their one-third share in the membership structure of the Basin Committees (*Comités de bassin*).

Users' participation is further fostered by legislation governing the direct involvement of water users in the management of groundwater resources in areas which experience particular problems, notably, accelerated groundwater depletion (also known as groundwater mining) and/or severe groundwater pollution. In Texas (United States), Groundwater Conservation Districts, traditionally formed on petition and vote by affected property owners, tend now to be formed also at Government's instigation of a property owners' election to create a district in so-called "critical areas", i.e., areas experiencing overdraft, insufficient supply, or contamination, based on studies conducted by Government. As noted earlier, whereas these Districts have varied powers including permitting, well spacing and setting the amount of withdrawals, most of them

have deferred to the rule of capture and have not imposed mandatory restrictions on the affected landowners' rights to pump and on the amount of water extracted. Most have opted, as a result, for voluntary self-restraint and educational programmes. In Spain, the proposed amendments to the 1985 Water Act mentioned earlier provide, among others, for the compulsory formation of Water Users' Groups from among the users of an aquifer, in particular when the aquifer is, or is at risk of becoming, overexploited (see 2.5 above). These groups are to share in the groundwater management responsibilities of the River Basin Authorities and, in particular, in the management and policing of groundwater extraction rights.

### 5.3. Conjunctive use of surface and underground water resources

The term "conjunctive use" of surface and groundwater has several different meanings but basically stands for maximizing the beneficial use and economic benefits of both surface water and groundwater through coordinated use. Methods include augmentation of supplies, allocation of costs, groundwater recharge and storage of surface water, and the coordination of rights reflecting the interconnection between the two kinds of sources.

The western states of the United States apply the rule of prior appropriation to interconnected surface and groundwater. As a result, priorities of rights to the use of interconnected waters are correlated and subject to a single set of priorities that encompasses the whole common water supply. In practice, new permits can be refused in the area, permissible total withdrawals can be apportioned among appropriators, junior appropriators can be restricted or curtailed in their withdrawals, the extraction and use of groundwater can be subjected to a rotation system and well spacing requirements can be introduced for new wells. In Texas, under legislation passed in 1997, irrigators using groundwater can move return flows to natural surface streams and divert and use such flows further downstream, without fear of losing their water as a result of appearing to "abandon" it. A Government permit to do so is first required, and the amount of return flow available for reuse will be subject to carriage losses in transit as well as any amounts needed by existing appropriators of the return flow. In both California and Arizona water users may store excess water underground when there is surplus flow available. The water is recharged underground subject to call or trade when needed. In addition, Arizona law allows any person to carry out groundwater recharge projects in return for groundwater recharge credits, under the likes of a groundwater "banking" mechanism. These credits may either be used by the recharger or sold to other water users. Arizona law further allows a person to deliver water directly to a farmer to be used by that farmer in lieu of water he would have pumped from under the ground (known as "in lieu recharge"). This effectively leaves in the ground water which the farmer would have pumped. The "in lieu" recharger receives groundwater credits which again can be used by the recharger or traded.

Under Jamaica's 1995 Water Act, interconnected surface and underground water resources can be dealt with as a single source of supply for the purposes of granting

new abstraction licences and curtailing existing licences, within designated "emergency areas". The amendments being contemplate to Spain's 1985 Water Act reflect a conjunctive use approach in respect of the expanded brief of the River Basin Authorities to implement plans and programmes for the integrated development of surface and groundwater resources; and in respect of the establishment of Boards for the Joint Development of Interconnected Surface and Groundwaters, with water users having a majority share in the relevant membership structure. In England and Wales, where current legislation attracts groundwater recharging within the scope of water abstraction licencing, thought is being given to de-regulation by replacing the licencing requirements with simpler and more expedient consent requirements.

## 6. Conclusions

The comparative analysis of the groundwater legislation passed in recent times in different countries suggests that groundwater is fast losing the intense private property connotation it has traditionally had and that user rights in it no longer accrue from ownership of overlying land but from a grant of the Government or of the courts. The public domain status of groundwater underpins the usufructuary nature of individual groundwater rights and the authority of the Government to grant such rights. Vested private property rights in groundwater need to be accommodated by new legislation, with the available case law suggesting that compensation claims are most unlikely to succeed. Regulated rights in groundwater provide the regulator with the flexibility needed to adjust allocation patterns to changing circumstances, to restrain the mining of groundwater and to practice the conjunctive use of surface and underground water, without detracting from the security of tenure which is desirable for investment decisions. Control of wastewater discharging on or under the ground, and control of land use practices are the keys to preserving the quality of groundwater from degradation – and the available stocks from irreversible total loss. Groundwater planning mechanisms and users' participation in decisionmaking play a key role in the success of legislation and, in particular, in reconciling the diversity of circumstances in the field with the uniformity of legislative provisions. In the last analysis, groundwater legislation need not be seen as solely prescriptive or restrictive of individual behaviour – or purely regulatory in scope. Not only can it, as a complement to regulating, seek to influence the behaviour of groundwater users through non-regulatory measures, notably charging. Legislation can also be enabling in scope and purpose, i.e., it can aim at regulation and other measures in incremental fashion and provide for the building blocks of such incremental approach, notably, the assessment of the resource and planning its development, conservation and protection from pollution; the provision of stand-by authority for the Government to experiment with designated regulatory and non-regulatory mechanisms as and where the circumstances so require; and the participation of groundwater users in the making, implementation, administration and policing of regulatory and non-regulatory decisions.