# *Protection of Groundwater (the case of Spain)*

# SUMMARY

- The groundwater in the European Directives.
- “Plan de Acción sobre Aguas Subterráneas” (*Action Plan on Groundwaters*)
- The groundwater in the Spanish Law.

# THE GROUNDWATER IN THE EUROPEAN DIRECTIVES

# GROUNDWATER PROTECTION: A PRIORITY IN EU ENVIRONMENTAL POLICY (REASONS)

- Contaminated groundwater: harder to clean than surface water and the consequences can last for decades;
- Frequently used for drinking water, for industry and for agriculture: dangerous for human health and threaten those activities;
- Provides the base flow for many rivers (up to 90% in some cases): influence in quality of surface water.
- Acts as a buffer through dry periods
- Is essential for maintaining wetlands.

# MAIN EUROPEAN DIRECTIVES ABOUT GROUNDWATER

- **Directive 2000/60/CE establishing a framework for Community action in the field of water policy (WFD)**
- **Directive 2006/118/CE on the protecction of groundwater against pollution and deterioration (PGD)**
- **Directive 80/68/ECC, on the protection of groundwater against pollution caused by certain dangerous substances.**

# Directive 2000/60/CE

# Establishing a Framework for Community Action in the Field of Water Policy (WFD)

# NORMATIVE EVOLUTION

- Declaration of the Ministerial Seminar on Groundwater (The Hague, 1991):

  - need to avoid deterioration of freshwater (quality and quantity);

  - programme of actions: sustainable management and protection of freshwater resources (2000).

- Resolutions of the Council (25-2-1992; 20-2-1997): requests an action programme for groundwater and a revision of Directive 80/68 on the Protection of Groundwater against Pollution.

# DEFINITIONS

• GROUNDWATER: “all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil” (art. 2.2 WFD).

•BODY OF GROUNDWATER: “a distinct volume of groundwater within an aquifer or aquifers” (art. 2.12 WFD).

•ACUIFER: “a subsurface layer or layers of rock or others geologial strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstratction of significant quantities of ground water” (art. 2.11 WFD).

# ENVIRONMENTAL OBJECTIVES OF GROUNDWATER (art. 4.1.b WFD)

Member States shall:

i) “Implement the measures necessary to prevent or limit the input of pollutants into groundwater and to prevent the deterioration of the status of all the bodies of groundwater (…)”

ii) “Protect, enhance and restore all bodies of groundwater, ensure a balance between abstraction and recharge of groundwater, with the aim of achieving **good groundwater status** (…)”

iii) “Implement the measures necessary to reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order progressively to reduce pollution of groundwater”.

# DETERMINAT FACTORS

The environmental objetives for groundwater depend of two factors:

1) Cuantitative status.
2) Chemical status.

# GROUNDWATER STATUS

GROUNDWATER STATUS: “the general expression of the status of a body of groundwater, determined by the poorer of its quantitative status and its chemical status” (art. 2.19 WFD).

GOOD GROUNDWATER STATUS: “the status achieved by a groundwater body when both its quantitative status and its chemical status are at least “good”” (art. 2.20 WFD).

# WHEREAS (WFD)

- (20) “The quantitative status of a body of groundwater may have an impact on the ecological quality of surface waters and terrestial ecosystems asociated with that groundwater body”.
- (28) “Surface waters and groundwaters are in principle renewable natural resources (…).”
- (34): “(…) there is a need for a greater integration of qualitative and quantitative aspects of both surface waters and groundwater (…)”.

# 1) QUANTITATIVE STATUS OF GROUNDWATER (art. 2 WFD)

QUANTITATIVE STATUS: “an expression of the degree to which a body of groundwater is affected by direct and indirect abstractions” (art. 2.26 WFD).

AVAIBLE GROUNDWATER RESOURCE: “the long-term annual average rate of overall recharge of the body of groundwater less the long-term annual rate of flow required to achieve the exological quality objectives for associated surface waters specified under Article 4, to avoid any significant diminution in the ecological status of such waters and to avoid any significant damage to associated terrestrial ecosystems” (art. 2.27 WFD).

GOOD QUANTITATIVE STATUS: “the status defined in table 2.1.2 of Annex V” (art. 2.28 WFD).

# DEFINITION OF QUANTITATIVE STATUS (TABLE 2.1.2 ANEX V WFD)

| Elements | Good Status |
|---|---|
| Groundwater level | The level of groundwater in the groundwater body is such that the **available groundwater resource is not exceeded** by the long-term annual average **rate of abstraction**.<br>Accordingly, the level of groundwater **is not subject to anthropogenic alterations** such as would result in:<br>.- Failure to achieve the **environmental objectives** specified under Article 4 for associated surface waters,<br>.- Any significant **diminution in the status** of such waters,<br>.- Any significant **damage to terrestrial ecosystems** which depend directly on the groundwater body,<br>and **alterations to flow direction** resulting from level changes may occur temporarily, or continuously in a spatially limited area, but such reversals do not cause saltwater or other intrusion, and do not indicate a sustained and clearly identified anthropogenically induced trend in flow direction likely to result in such intrusions. |

# MONITORING OF GROUNDWATER QUANTITATIVE STATUS (ANEX V.2.2 WFD)

2.2.1. Groundwater level monitoring network (arts. 7 and 8).

2.2.2. Density of monitoring sites.

2.2.3. Monitoring frequency.

# 2) CHEMICAL STATUS

• PARAMETERS FOR THE DETERMINATION OF GW CHEMICAL STATUS (2.3.1 of Annex V):

- Conductivity.
- Concentration of pollutants.

• GOOD GW CHEMICAL STATUS: “the chemical status of a body of groundwater, wich meets all the conditions set out in table 2.3.2 of Annex V” (art. 2.25 WFD).

# DEFINITION OF CHEMICAL STATUS (TABLE 2.3.2 ANEX V WFD)

| Elements | Good Status |
|---|---|
| General | The chemical composition of the groundwater body is such that the **concentrations of pollutants**:<br>- As specified below, **do not exhibit the effects of saline or other intrusions**<br>- Do **not exceed the quality standards** applicable under other relevant Community legislation in accordance with Article 17<br>- Are **not such as would result in failure to achieve the environmental objectives** specified under Article 4 for associated surface waters nor any significant diminution of the ecological or chemical quality of such bodies nor in any significant damage to terrestrial ecosystems which depend directly .in the groundwater body. |
| Conductivity | Changes in conductivity are not indicative of saline or other intrusion into the groundwater body |

# MONITORING OF GROUNDWATER CHEMICAL STATUS (ANEX V.2.4 WFD)

2.4.1. Groundwater monitoring network (arts. 7 and 8).

2.4.2. Surveillance monitoring.

2.4.3. Operational monitoring.

2.4.4. Identification of trends in pollutants.

# INTREPRETATION AND PRESENTATION OF GROUNDWATER STATUS (ANEX V.2.5 WFD)

- Map showing for each GW body:
- Quantitative status.
- Chemical status.
- Colour-code:

  Green: Good

  Red: Poor

  Black: Trend in pollutant concentration

  Blue: Reversal of a trend

# OTHERS BASIC MEASURES OF THE PROGRAMME OF MEASURES

- Controls over the abstraction of fresh groundwater, with a register of water abstractions (with prior authorisation) (art. 11.3.e WFD)
- Controls (with prior authorisation) of artifical recharge or augmentation of groundwater bodies (art. 11.3.f WFD)
- Prohibition of direct discharges of pollutants into GW (art. 11.3.j WFD)

# Directive 2006/118/CE on the Protecction of Groundwater Against Pollution and Deterioration (PGD)

# BACKGROUND ("Daughter Directive")

- **WFD (Oct. 2000):**
- Stated that measures would be adopted to prevent and control groundwater pollution.
- 2013: will repeal Directive 80/68.
- **PGD (Dec. 2006):**
- Set out these measures of WFD.
- Fill the legislative gap following the repeal of Directive 80/68.

# AIMS AND MEASURES OF PGD (Art. 1)

- AIMS: to prevent and combat groundwater pollution.
- MEASURES:

  - criteria for the assesment of good chemical status of groundwater (art. 3 PGD).

  - criteria for the identification an reversal of significant and sustained upward trends (in groundwater pollution levels) and for the definition of starting points for trend reversals (art. 4-5 PGD).

  - preventing and limiting discharges of pollutants into groundwater (art. 6 PGD).

# GOOD GROUNDWATER CHEMICAL STATUS (art. 4.2 PGD; Annex V WFD)

- **Annex I PGD:**

- Nitrate levels: not exceed 50 mg/l

- Active pesticide ingredients: not exceed 0.1 g/l (0,5 g/l for all pesticides measured);

- **Art. 3, Annex II PGD:** Levels of certain high-risk substance: below the threshold values set by Member States. This must include, at least: ammonium, arsenic, cadmium, chloride, lead, mercury, sulphate, trichloroenthylene and tretra chlororoethylene;

- **Other pollutants: Annex V WFD**.

- If a value set as a quality standard or a threshold value is exceeded: an investgation confirms that this does not pose a significant environmental risk.

## THE PRESENCE OF POLLUTANTS IN GW

- Dec. 2008: Member States must set a threshold value for each pollutant identified in GW considered to be at risk (Anex III PGD and River Basin District Management Plans).
- Dec. 2009: the Comission will draw up a report based on the information provided by Member States.
- Member States (Anex IV PGD):

  - Monitoring programme.

  - Identify any significant upward trend in level of pollutants and define a starting point for reversing these upward trends.

# PREVENTING AND LIMITING DISCHARGES OF POLLUTANTS

- River Basin District Management Plans must include:

  - preventing indirect discharges of all pollutants (hazardous substances ANNEX VIII.1-9 WFD).

  - pollutants not listed as hazardous: be limited if they pose a real or potential risk of pollution.

# PLAN DE ACCIÓN SOBRE AGUAS SUBTERRÁNEAS (*Action Plan on Groundwaters*)

# RELEVANCY OF GROUNDWATER

- Water for human consumption (19 %)
- Agriculture (22 %)
- 500.000 not registered wells.
- 3.600 hm3/year of groundwater extracted illegally (44 % of the whole); 4.500 extracted legally.
- Priority aspect of the water policy: Action Plan on Groundwaters (*Plan de Acción sobre aguas subterráneas*)

# PLAN DE ACCIÓN SOBRE AGUAS SUBTERRÁNEAS

- Directive 2006/118/CE on the protection of groundwater against pollution and deterioration (PGD).
- Art. 29 National Water Plan.
- Coordinated by the Environment and Rural and Marine Ministry, for intercommunity basins.
- Implementation Plan: 2006-2010
- Content:
  - Adapts its policy to the programs of measures included in the river basin management plans;
  - Administrative actions: programs, research activities, project and technical analysis, investments.

# TYPES OF GROUNDWATER

- Bodies GW at risk of not achieving environmental objectives (year 2015).
- Bodies at risk (in study).
- Bodies without risk.

# MONITORING AND CONTROL NETWORK

*CONSTRUCTION PROGRAM OF CONTROL SURVEYS*

- Purpose: the adequacy of piezometric networks and chemical quality networks to the requirements of the WFD.
- Conclusion: in 2009.
- 1946 monitoring quantitative status stations
- 1929 monitoring chemical status stations
- Planned investment (2006-2010): 40 M €

# MONITORING PROGRAM OF THE CUANTITATIVE STATUS

- Control element: level of groundwater.
- Background: Art. 8 and Annex V.2.2 WFD.
- Objective: To provide a reliable assessment of the evolution of quantitative status of all groundwater bodies.

# MONITORING PROGRAM OF THE CHEMICAL STATUS

- Basic element: a network of monitoring stations.
- Background: Art. 8 and Annex V.2.4 WFD.
- The Program includes:
  1) Control monitoring of all groundwater bodies.
  2) Operational control for groundwater bodies at risk of not achieving good chemical status by 2015.

# BASIC PARAMETERS OF CHEMICAL CONTROL

- Required by the WFD:
  - Dissolved oxygen.
  - PH.
  - Conductivity.
  - Nitrates.
  - Nitrites.
- The program included also other parameters.

# PARAMETERS INCLUDED IN THE MONITORING CONTROL

- Majority ions: chlorides, sulfates, carbonates, bicarbonates, calcium, magnesium, sodium, potassium, silica.
- Additional parameters: nitrates, nitrites, ammonia, COD, total cyanides, fluorides.
- Metals: iron, manganese, arsenic, mercury, cadmium, chromium, copper, lead, zinc, nickel, beryllium, cobalt, selenium, vanadium, barium.

# SUSTAINABLE EXPLOITATION AND EXTRACTION

- Groundwater in poor condition or at risk of not achieving the environmental objectives (WFD): analysis of the characteristics and propose actions (into the program of measures for demarcation).
- Reglamento del Dominio Público Hidráulico: revision (sustainable exploitation of groundwater).
- Investment target: 90 M €.

# COMMUNITIES OF GROUNDWATER USERS (CUAS)

- Revision of Water Law (TRLA) that includes provisions for the constitution, organization and functions of the CUAS.
- Purpose of this program: development of a methodological guide and its application in a pilot area.
- Program implementation: 2007-2008.

# PROTECTION: CONTAMINATION AND QUALITY DETERIORATION

- PWD: criteria for assessing the GW chemical status and for determining significant upward trends in pollution.
- Purpose of program:
  - Guide on the basics Directive elements;
  - Diagnosis update on the groundwater bodies chemical status.
- Development: 2007-2009.
- Investment: 400.000 €.

# PROTECTION PERIMETRES OF CATCHMENTS

- Purpose: to preserve the GW quality in catchments for water supply by establishing perimeters of protection, within which limits or prohibits development of polluting activities (Technical and Health Regulations on Drinking Water and art. 173 RDPH ).
- Development: 2008-2009.
- Investment: 300.000 €

# PRESERVATION OF AQUATIC ECOSYSTEMS GROUNDWATER DEPENDENTS

- Arts. 43, 99 bis y 111 Water Law.
- Purpose:
  - Identification and description of GW dependents wetlands;
  - Establishment of action strategies in resource use to solve critical situations;
  - Drafting of a specific proposal for each case.
- Development: 2008-2009.
- Investment: € 820,000.

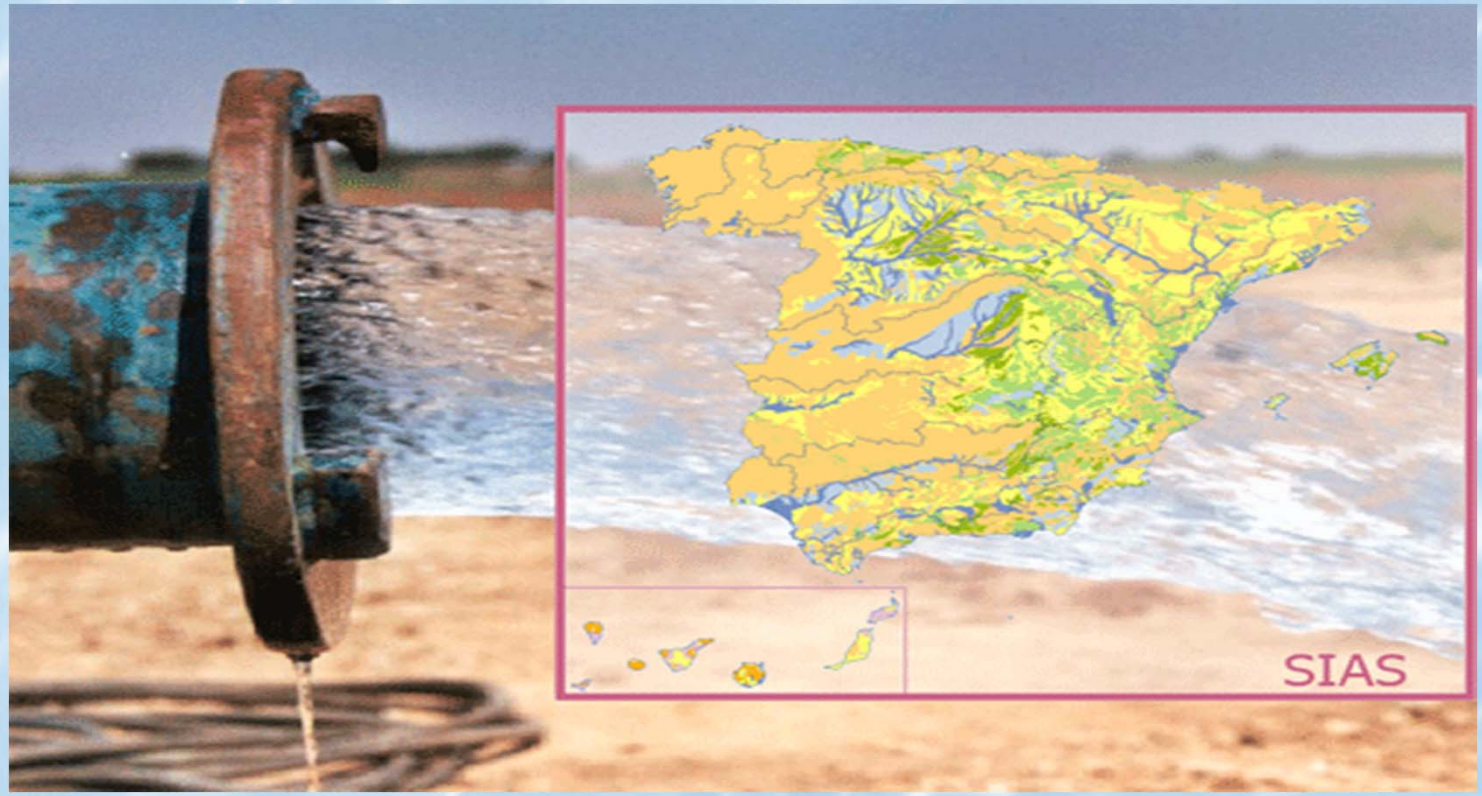
# JOINT USE. CATCHMENT GROUNDWATER (DROUGHT)

- Purpose:
  - Analysis of available groundwater resources. In particular, those sensitive to shortages of resources and for the supply of drinking water.
  - Establish additional infrastructures for groundwater catchment.
  - Special action plans in alert situations and eventual drought.
- Investment: 390.000 €

# ARTIFICIAL AQUIFERS RECHARGE

- Storage technique not sufficiently developed in Spain.
- Objective: promote the increase of this availability through the development of the basins organizations proposals (with the relevant viability studies).
- Development: 2008-2009.
- Investment: 84.000 €

# SISTEMA DE INFORMACIÓN DEL AGUA SUBTERRÁNEA (SIAS)
# (GROUNDWATER INFORMATION SYSTEM)




Integra the institutional databases
and offers them to the users

# SITUATION REPORT (ENVIRONMENT MINISTRY)

- Published monthly.
- Includes:

  - Data of the aquifers recharge .

  - Analysis of the evolution of the groundwater average level in each basin for the last twelve months.

  - Information, recorded in the last ten years (for each basin), of the positions of maximum and minimum for each month.

# THE GROUNDWATER IN THE SPANISH LAW

# DEFINITION

- El agua infiltrada en el subsuelo se acumula a través de los poros, grietas y fisuras de los materiales que, por su naturaleza, tienen capacidad de almacenarla y transmitirla. Estas formaciones geológicas que contienen o han contenido agua y por las cuales el agua puede fluir son las que, con carácter general, se denominan acuíferos. (*Libro blanco de las aguas subterráneas*).
- Una masa de agua subterránea es un volumen claramente diferenciado de aguas subterráneas en un acuífero o acuíferos. (Ley de Aguas, art. 40 bis.f).
- Acuífero o formación geológica por la que circulan aguas subterráneas (art. 12 Ley de Aguas).

# PUBLIC HYDRAULIC DOMAIN

**Constituyen el dominio público hidráulico:** (art. 2 Ley de Aguas)

- Las aguas continentales, tanto las superficiales como las subterráneas renovables con independencia del tiempo de renovación.
- Los cauces de corrientes naturales, continuas o discontinuas.
- Los lechos de lagos y lagunas y los de embalses superficiales en cauces públicos.
- Los *acuíferos subterráneos*, a los efectos de los actos de disposición o de afección de los recursos hidráulicos.
- Las aguas procedentes de desalación de agua del mar.

# TIPE OF USES OF HIDRAULIC PUBLIC DOMINE

Arts. 50, 51 y 52 Ley de Aguas:

- **Usos comunes** de tal forma que "todos pueden, sin necesidad de autorización administrativa y de conformidad con lo que dispongan las Leyes y Reglamentos, usar de las aguas superficiales, mientras discurren por sus cauces naturales, para beber, bañarse y otros usos domésticos…". Se establece la forma en que deben llevarse a cabo tales usos.
- **Usos comunes especiales** sujetos a obtener previamente una autorización administrativa, como la navegación y flotación, embarcaderos…
- **Uso privativo**, sea o no consuntivo, que requiere la obtención previa de una concesión administrativa o que se establezca el derecho a su uso por disposición legal. El derecho a cada uso privativo se transcribe al Registro de Aguas existente en el Organismo de cuenca que corresponda según la situación geográfica del aprovechamiento.

# PRIVATE USES OF GROUNDWATER

- El propietario del fundo no puede realizar obras cuya finalidad sea la extracción o aprovechamiento del agua o que perturben su régimen o deterioren su calidad (art. 12 Ley de Aguas, sensu contrario).
- Posibilidad de utilizar aguas de manantiales de un predio o aprovechar en él aguas subterráneas: límite de 7.000 m3 (art. 54.2 Ley de Aguas).
- En acuíferos sobreexplotados (o en riesgo de estarlo): no se pueden realizar nuevas obras sin autorización (art. 54.2 Ley de Aguas).

# AQUIFEROUS SOBREEXPLOTADOS (O EN RIESGO DE ESTARLO)

Art. 56 Ley de Aguas:

- Declaración por el organismo de cuenca competente.
- En dos años: Plan de Ordenación para la Recuperación del acuífero, para lograr una explotación racional.
- Hasta la aprobación del Plan: limitaciones de extracción, preventivas y cautelares.
- El Plan puede contener:

  - Perímetro dentro del cual no es posible el otorgamiento de nuevas concesiones.

  - Perímetros de protección, para evitar contaminación (exigencia de autorización).

# PROTECTION OF THE GROUNDWATER OPPOSITE TO SALINE WATERS

Art. 99 Ley Aguas

- Limitación de la explotación de los acuíferos afectados.
- Redistribución espacial de las captaciones existentes.
- Criterios básicos: se incluyen en el Plan Hidrológico de Cuenca.

# AUTHORIZATION OF SPILLAGE IN AQUIFEROUS AND GROUNDWATER

Art. 102 Ley de Aguas:

- Cuando un vertido pueda dar lugar a la infiltración o almacenamiento de sustancias susceptibles de contaminar los acuíferos o las aguas subterráneas, sólo podrá autorizarse si el estudio hidrológico previo demostrase su inocuidad.

This work was supported by a grant from the "Programa de desarrollo territorial y gestión del agua en la Comunidad de Madrid", funded by Comunidad de Madrid (S2007/HUM-0474).
**PI:** Prof. Catedrático Ángel Menéndez Rexach