DISCUSSION DOCUMENT

Towards a European Drought Policy

Prepared by the EurAqua network
of Europe's leading freshwater
research organizations

EurAqua

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This document has been prepared for senior policymakers and politicians, with the objective of promoting discussion on:

1. Drought as an important and common characteristic of the European environment,
2. The major economic, social and environmental costs of European droughts,
3. The need for a specific European Drought Policy, within the context of long term sustainable use of water resources in Europe,
4. The need to integrate drought into a wide range of other EU policies and
5. The need for specific drought mitigation measures (drought forecasting, monitoring, research and knowledge sharing) at European level.

The observations and recommendations contained within this Discussion Document build upon a number of recent research projects, studies, workshops and conferences on drought at a European scale. This document is the product of the combined experience of EurAqua member organizations in developing international, European and national drought mitigation methods and tools, and of comparisons with current international best practice.

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Contents

Introduction

This Discussion Document has been prepared by the EurAqua Network of European Freshwater Research Organizations. Factors which prompted this initiative include:

- The severity of the drought which affected much of Europe during 2003,
- The increased potential for collaboration on water issues at European level,
- Recent advances in the scientific understanding of droughts,
- Europe is lagging behind other advanced countries in drought mitigation, and
- The low priority given to drought issues in European policies.

It is hoped that this document will raise the profile of droughts as a very real threat to Europe and show that drought causes economic damage equivalent to that of floods. The document seeks to provoke a wider discussion about how droughts are addressed across all EU policy areas, and the need for a specific European Drought Policy. It is hoped that, as a result of these discussions, action will be taken which will significantly reduce Europe's economic, social and environmental vulnerability to droughts.

1. Europe's vulnerability to drought

Drought is one of the major weather related disasters and recent events have demonstrated Europe's continuing exposure to this natural hazard. Drought conditions develop slowly, often unnoticed, and can persist for years over very wide areas with serious economic, social and environmental consequences. Drought is a recurrent feature of the European climate[1], occurring in both high and low rainfall areas and in any season. The impacts depend on the severity, duration and spatial extent of the rainfall deficit but also, and to a large extent, on the environmental and socio-economic vulnerability of the affected region. Many parts of Europe suffer water stress, and it is these areas which are most at risk from drought. Climate change modeling[2], using a range of climate scenarios, has predicted that droughts will increase in intensity across most of western Europe (with the maximum deficit volume increasing by over 50% in some areas).

Despite some awareness of this hazard, there is currently no European Drought Policy and institutional frameworks to cope with the threat of drought at European level are poorly developed[3]. There is a growing need for drought to feature more strongly on the political agenda since:

[1] EEA, 2001: Sustainable water use in Europe. Part 3: Extreme hydrological events: floods and droughts (Environmental issue report No 21). Copenhagen: European Environment Agency.

[2] Arnell, N.W., (1999). The effect of climate change on hydrological regimes in Europe: a continental perspective. Global Environmental Change 9 (1999), 5-23.

[3] Vogt, J.V. & Somma, F. (eds.) (2000) Drought and Drought Mitigation in Europe, Kluwer.

- Droughts are a major threat to the economic and social well-being of European citizens.
- Europe's vulnerability to drought is increasing due to growing water demand by sectors and regions, and the expected impact of climate change.
- While drought planning in some member states is at an advanced level, and compares favorably with practices elsewhere in the world, the extent and effectiveness of drought management procedures is highly variable between member states. The approach adopted is too often reactive "crisis management" rather than proactive risk management.
- Despite the often vast scale of European droughts (Figure 1) there is no coordinated European drought forecasting, monitoring and mitigation network, or commitment to drought research and best practice.

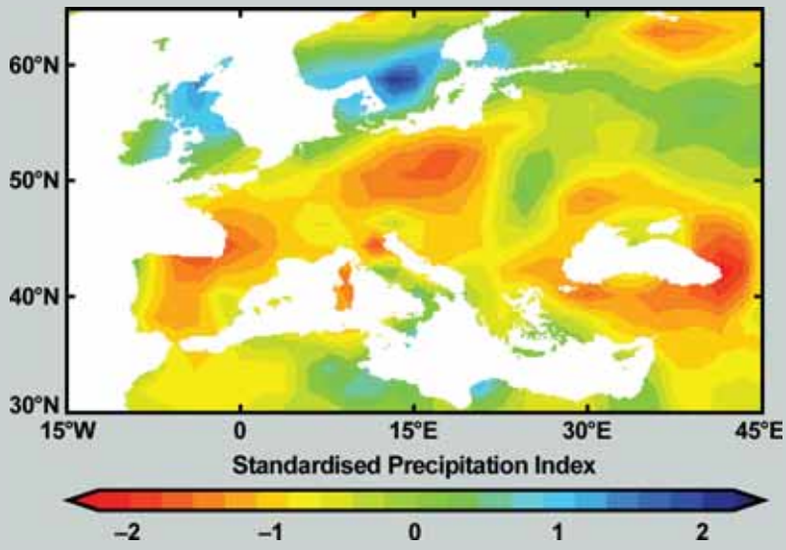


Figure 1: Extent and severity of 2003 drought

During the summer of 2003, the rainfall deficit extended across most of Europe with drought conditions lasting from March to September. In Central and Eastern Europe 2003 followed a cluster of notably dry years.

2. What is the economic cost of drought to Europe?

Drought affects all sectors of society in very complex and interactive ways and therefore its economic cost is difficult to quantify. Planning for future droughts requires good data, and the capability to interpret it appropriately. Typically, published data on the economic cost of a drought is based upon one sector, in one area, and in one year.

There is currently no established methodology to quantify the economic, social and environmental costs of droughts, although advances have been made by the UN Economic Commission for Latin America and the Caribbean (ECLAC). The EC Humanitarian Office (ECHO) has also sponsored studies on how these methodologies might be developed[4]. Improved methods are essential to making reliable estimates of the economic costs of climate induced changes in European drought severity. Despite these difficulties, it is apparent from Table 1 that droughts have a major economic impact upon Europe.

[4] Assessment of the Economic Impact of Natural and Man-Made Disasters - Expert Consultation on Methodologies. Held at Centre for Research on the Epidemiology of Disasters (CRED). 29 - 30 September 1997. Brussels

Period	Region / Countries affected	Economic costs (€ billion)
1976-77	**Western Europe** Cost of building damage due to land subsidence in London alone estimated at € 800 million	
1981- 82	**Iberian Peninsula** (Portugal, Spain, Southern France, Corsica, Italy)	> 5.0
1988- 91	**Mediterranean Region** (Portugal, Spain, Southern France, Italy, Albania, Greece)	> 2.1
1992- 94	**Eastern Europe** (Germany, Denmark, Poland, Lithuania, Hungary, Yugoslavia, Ukraine, Moldova)	> 1.1
1992- 95	**Spain**	> 3.7
2000	**Central Europe** (Romania, Hungary, Poland, Bulgaria, Greece, Yugoslavia, Czech Rep, Turkey, Germany)	> 0.5
2003	**Europe** (Romania, Hungary, Poland, Bulgaria, Greece, Yugoslavia, Czech Rep, Austria, Switzerland, Italy, Germany, Belgium, Denmark, Netherlands, Norway, UK, France, Spain, Portugal)	> 11.6

Table 1 Minimum economic cost of recent major drought events in Europe (from Munich Re[5], EEA, COPA-COGECA and other sources)

Economic costs of drought compared to floods

Munich Re has estimated the total economic cost of the 2003 drought as approximately US$13 billion, which is comparable to their estimate of US$13.5 billion for the August 2002 floods. This is consistent with a recent study by the US National Drought Mitigation Centre (1998) which summarized the socio-economic impact of droughts - comparing the warning time, the duration, the frequency, the fatalities, the costs and losses and the spatial extent with similar figures for floods and hurricanes. The costs of the worst recent drought in the USA (1988-89, US$39-40 billion) were on average more than twice the costs of the worst flood (1993, Mississippi valley, US$15-28 billion).

[5] Munich Re: NatCat Database of European droughts, heat waves and forest fires (1976-2003)

3. What causes European droughts?

Droughts are complex phenomena, the result of a combination of meteorological conditions (low rainfall and high temperatures), land surface conditions (land use, soil moisture), and water use practices. Northern and southern European droughts tend to be caused by different meteorological conditions, and land use and water resource management practices. Three general types of drought are recognized: meteorological droughts – defined on the basis of rainfall deficiency; hydrological droughts – where accumulated shortfalls in river flows or groundwater replenishment are of primary importance; and agricultural droughts - where the availability of soil water through the growing season is the critical factor. During lengthy droughts, all three categories may combine to increase water stress.

It is important to distinguish between droughts (which are a departure from normal conditions), and natural aridity due to low rainfall. It is also important to distinguish between aridity (which is a natural condition) and water stress - which arises when water demands by society exceed the capacity of the natural system.

Climate

For Europe the dominant influence upon climate variability is the global atmospheric circulation pattern and, in particular the tracks followed by rain-bearing Atlantic frontal systems. It is when large high pressure systems develop and persist over continental Europe that major droughts occur; normal rain bearing storms are blocked/diverted to either lower or higher latitudes.

Droughts are caused by large, global scale climatic drivers. As a result droughts often affect large areas and can continue for several seasons – causing "clusters" of drought years.

Ultimately these systems can produce exceptionally protracted rainfall deficiencies such as occurred over much of western Europe during the late nineteenth and early twentieth century[6]. While there have been no close recent parallels to drought episodes of such duration, the 1975/76 drought was of unprecedented intensity over parts of Europe (from western Germany to the English Midlands)[7].

However, the event was perceived, at the time, to be extremely rare – with return periods exceeding 100 years in many regions. As a consequence, it did not provide a sufficiently strong stimulus for the development of cross-sectoral coping strategies appropriate for the potential increases in drought magnitude as global warming intensifies.

[6] Thomsen, R. 1993. Future Droughts, Water Shortages in Parts of Western Europe. EOS Transactions, Vol. 74, No. 14, 161-165

[7] Doorkamp, J.C., Gregory, K. J. and Burn, A.S. 1980. Atlas of Drought in Britain. Institute of British Geographers. 86 pages.

Water resources and drought management

Reservoirs, rivers and aquifers are sustained not by rainfall directly but by that proportion which remains after evaporative demands have been met. Evaporation losses are concentrated in the summer half-year and impose a strong seasonality on river flows and groundwater replenishment. On average about 75% of Europe's rainfall is lost to evaporation, increasing to more than 90% in the driest regions. Thus, variability in river flows and groundwater replenishment is normally much greater than for rainfall. Evaporation losses mean that relatively minor rainfall deficiencies can translate into large deficiencies in runoff and aquifer recharge. Adequate river flows and groundwater monitoring networks are therefore essential to assess the severity of drought episodes. Where countries are underlain by permeable rock, their water needs are commonly met from groundwater. In other areas summer flows are maintained by water held as snow and ice. Both types of storage provide a buffer which greatly reduces national vulnerability to short-term droughts. However, where several dry winters cluster together, this buffering capacity is reduced and severe drought conditions may develop.

Human Factors and Water Management

The impact of drought can be greatly exacerbated by the inefficient use of water, inadequacies in infrastructure, water use, demand management, governance structures, and in legislative frameworks and regulatory mechanisms. Poor adaptation to drought may reflect a limited understanding of how patterns of water availability, water use and land use can increase or moderate drought vulnerability. Poor monitoring or reporting capabilities can prevent the timely introduction of mitigation measures. Possibly most importantly - an absence of political will may mean that unsustainable water use practices are never addressed.

In parts of Europe, the increased integration of water resource systems at the regional level, often involving the optimal exploitation of both surface and groundwater sources, has significantly increased capabilities to withstand the impact of within-year drought episodes.

Demand management initiatives offer the potential for ensuring that limited water resources are utilized in a sustainable way.

Demand measures will need to be tuned to local and national circumstances, and may include economic instruments, leakage control, water-reuse and recycling, and generally increased efficiency of domestic, agricultural and industrial water usage.

4. Climate change and droughts

Global warming is predicted to have a significant impact on the world's climate, but uncertainties remain about the precise nature of these changes. It is difficult to seperate climate change impacts from natural climate variability. However, it is the changes in these climate extremes that will have a direct impact on the frequency and severity (in space and time) of drought episodes across Europe.

The latest climate change scenarios suggest significant summer drying across many parts of Europe, particularly in the Mediterranean basin, with increased number of hot days[9]. These scenarios also suggest lower rainfall in some areas for spring and autumn and an increased variability in winter rainfall. Combining these patterns of change leads to an assertion that over the next 100 years Europe is likely to suffer more frequent meteorological droughts, especially in the south. With generally elevated temperatures (scenarios suggest average summer temperatures between 2 and 6°C higher than at present) these rainfall deficits are likely to be accompanied by higher evaporative demand. These events might manifest themselves both as short, but extreme, single season droughts (such as the hot summer of 2003) and longer-term, multi-season droughts.

A comprehensive framework for reducing Europe's vulnerability to droughts is essential in preparing for conditions of increasing drought frequency and severity.

5. Impacts of drought – Lessons from 2003

The 2003 drought was a stark reminder of Europe's vulnerability to drought, demonstrating clearly what can happen when an exceptional rainfall deficit is combined with extended heat-wave conditions. The diversity and far reaching effects of the 2003 drought are illustrated in the following selected examples. The impacts in Italy were particularly severe, with the country on the brink of a national emergency. The tragic effects of "la canicule" (extreme heat wave) of 2003 has left a profound social and political impression upon the people of France.

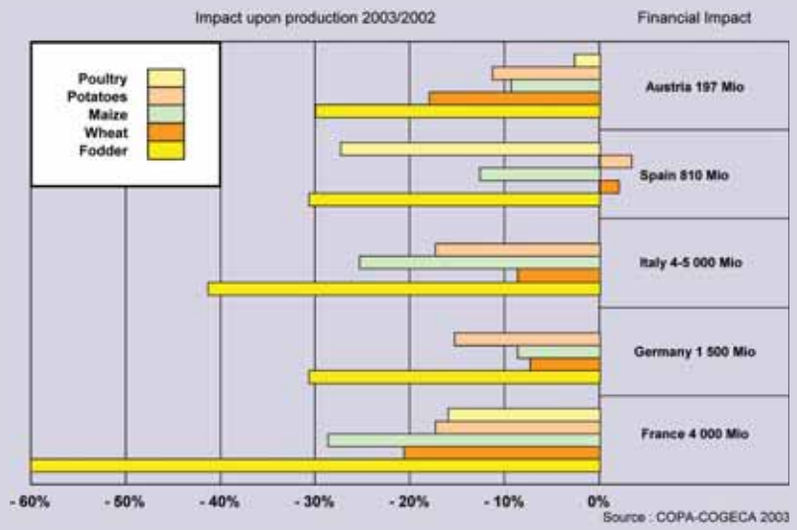


Figure 2: Impact of the summer 2003 heat wave and drought on agricultural and forestry in 5 selected countries

Agriculture was particularly badly affected, with farm lobby groups in the EU estimating losses of €11 billion. Typical agricultural production losses are shown in Figure 2[10].

For example, the reduced production of green fodder required importing this bulky commodity from as far away as the Ukraine, the early slaughtering of cattle and reduced carry over of feed for livestock for 2004.

EU cereal production was 23 mio tonnes below that of 2002, requiring imports and depletion of carry over stocks.

[9] IPCC (2001) Climate Change 2001: The Science of Climate Change. Cambridge University Press: Cambridge

[10] COPA COGECA 2003: Assessment of the impact of the heat wave and drought of summer 2003 on agriculture and forestry. http://www.copa-cogeca.be/pdf/pocc_03_78i4_1e.pdf

In addition to the direct economic costs, the increased water demands of agriculture (and particularly irrigated agriculture) played a very significant role in making drought conditions worse.

Forestry stocks were adversely affected by both fire and die-back. Exceptionally dry conditions and high temperatures resulted in over 25,000 reported heath and forest fires, extending from Portugal (losses in excess of €1 billion) to Ireland and Finland. In total, 650,000 ha of EU forests were destroyed by fire. In Switzerland widespread die-back was attributed to the drought, with trees becoming susceptible to attack from a variety of pests. The reduced yields of many forestry crops grown for biomass will affect energy production for many years to come.

Tourism is of vital importance to many of Europe's less developed regions. During the summer of 2003, the number of tourists visiting Spain from northern European countries fell by over 800,000 as people chose to stay at home to enjoy warm and sunny local conditions.

Navigation was restricted on rivers such as the Danube, Rhine and Po as a result of the 2003 drought. Individual river ports on the Danube reported losses of several millions of Euros.

Energy production - Thermal and nuclear power plants were closed because of either a lack of water for cooling systems, or restrictions on discharging heated waters. Hydropower production was reduced in Norway, France and Germany. Power cuts occurred in Italy, France and Germany – with knock-on losses across many other industrial sectors.

Water supply - Drying up of boreholes, springs and wetlands and restrictions on water use and abstractions was common across much of Europe. In eastern Austria, the drought prompted the construction of additional domestic and industrial water supply networks at a cost of €40 million. In 2003 the seasonal decline in groundwater resources was exceptionally steep with groundwater levels reaching 100 - year record lows. In the Netherlands, salt water intrusion has been estimated to increase the agricultural costs of drought by 10%. A change in the management policy is under consideration as part of the Netherlands Drought Study[11]. The exceptionally dry soil conditions and clay shrinkage in 2003 caused structural damage to buildings and increased leakage from water supply pipes. In southern England, insurance claims for building subsidence have increased by an estimated €400 million in 2003.

[11] Netherlands Drought Study. Final Report Phase 1, March 2003, Rijkwaterstaat RIZA, ARCADIS

Biodiversity - In 2003 terrestrial, freshwater and coastal ecosystems were all put under exceptional stress, with increased risk to biodiversity loss[12]. Fish kills due to high temperature and increased pollution loads and low flows were reported as far north as Scotland, while eutrophication affected many southern lakes and rivers. In France, emergency exemptions from environmental legislation (e.g. on discharging heated water from power stations) were taken at the expense of the environment.

Heat stress - The summer of 2003 was the warmest on record (in a series extending back over 240 years); the associated heat stress contributed to the deaths of more than 30,000 people.

6. A European framework for drought mitigation

In the USA, Australia and South Africa a recent succession of severe and extensive droughts have led to a fundamental reappraisal of drought mitigation strategies. The 2002 drought in the USA stimulated many water conservation and demand management initiatives. The ongoing drought in Australia has led to a wide-ranging approach to ameliorate drought impacts and reduce long-term pressures on water resources at both national and state level.

Europe should view 2003 as a wake-up call. The 2003 drought should be the catalyst to develop a European policy on drought mitigation. These measures must be compatible with the overarching goal of sustainable water use, with demand management one of the primary means of achieving this goal.

Policy framework

Despite its profound effects, drought receives scant attention in many areas of European policy. In agricultural policy, drought is rarely mentioned despite having major direct impacts (water stress in all plants, reduced water for irrigation, increased water pumping / transportation costs). and indirect impacts (soil erosion and desertification). The Common Agricultural Policy supports water intensive practices in regions with high water stress and vulnerability to future droughts.

The social and economic fabric of some EU regions is now heavily dependent upon unsustainable water management practices.

European forest policy makes isolated references to optimizing recharge, but does not address the impacts of drought on forest health, reduced biomass production (for building and energy), or the high water consumption of some energy crop species. Despite impacts on hydropower resources, restrictions on both abstractions and discharges of cooling water, and increased electricity demands from consumers – drought is not mentioned in European

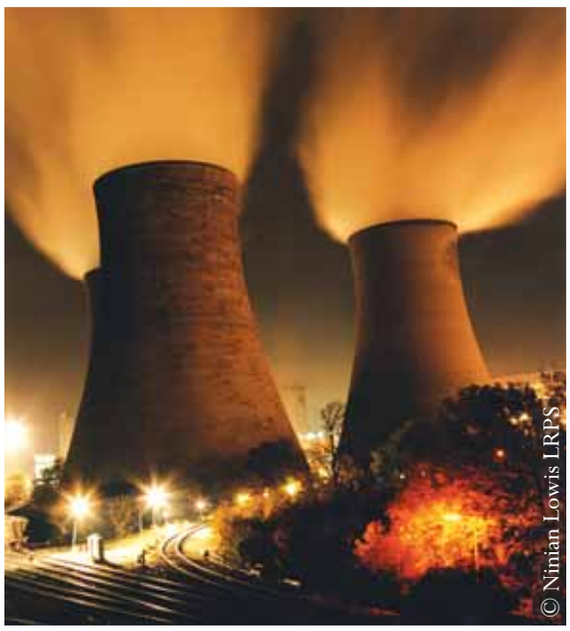
[12] "Vulnerability of European ecosystems facing an increasing drought risk". International Workshop as part of the AVEC Concerted Action, held in Samos, Greece – April 2003.

energy policies. European transport policy (navigation) makes no reference to low flow conditions. European tourism policies, while giving some consideration to water resource issues, do not consider specific drought conditions and their wider impacts. Similarly, health policies make few provisions for reduced water supplies and deteriorating water quality. Although significant progress is being made on how to reconcile environmental and human water requirements, little consideration has been given in policies or contingency planning to prevent biodiversity loss during prolonged droughts.

During a protracted drought, political and policy initiatives would need to be soundly based to ensure that trans-boundary mitigation measures are effective and equitable, and to preserve cohesion and avoid real damage to the social and economic fabric of the EU.

In contrast to internal policy, drought is addressed as a real issue in EU development policies. Drought is seen as a threat to sustainable development, a humanitarian issue and a driver of mass migration and political instability. The inadequacies of Europe's internal drought policies, planning and operations reduce the EU's authority in influencing drought related initiatives at international level.

The very wide cross sectoral impact of droughts suggests that the issue be addressed as an explicit European policy. This should be supported by actions to achieve greater coherence between European policies for all sectors affected by, or contributing to, drought.



The Water Framework Directive

The Water Framework Directive and the Common Implementation Strategy provide a mechanism for the development and implementation of a European Drought Policy. The emphasis of the WFD upon river basin integrated water resource management and strong involvement of stakeholders, provides a starting point for European drought mitigation.

The requirement under the Directive to ensure the quantitative status of groundwater bodies (balancing abstractions with recharge), even in water stress and shortage situations, supports more sustainable water abstraction regimes. While an objective of the WFD is to "contribute to mitigating the effects of …

droughts" (Art.1.(e)), some of its provisions are not fully consistent with good drought mitigation practices. The WFD considers that prolonged droughts "can not reasonably have been foreseen" (Art.4.6). Prolonged droughts are therefore "grounds for exemptions from the requirement to prevent further deterioration or to achieve good status" (Preamble (32)) where "additional measures are not practicable" (Art.11.5). The Measures which directly relate to drought mitigation are left as optional supplementary measures (Annex VI, Part 5).

In some respects the WFD treats drought as a crisis which triggers exemptions, rather than a risk to be managed and mitigated.

In addition, while the WFD refers to "drought" – the European Environment Agency, notes that there is no consistent definition for drought on a European level. A drought as "defined" by the WFD could be a "resource" drought, resulting from fundamentally inappropriate water management, not the result of meteorological conditions. In these circumstances exemptions under the WFD could entrench inefficient water management systems.

A European Drought Policy is needed to better reconcile the water supply requirements of industrialized society with the ecological status objectives of the Water Framework Directive.

7. International best practice in drought mitigation

A number of recent studies, research projects and drought workshops[13] have concluded that while in some member states drought planning is of world standard, in other member states this is not the case. At European scale the EU lags behind other industrialized countries with respect to drought policies, planning and operational aspects. These deficiencies directly affect the resilience of the EU economy and European competitiveness on global markets.

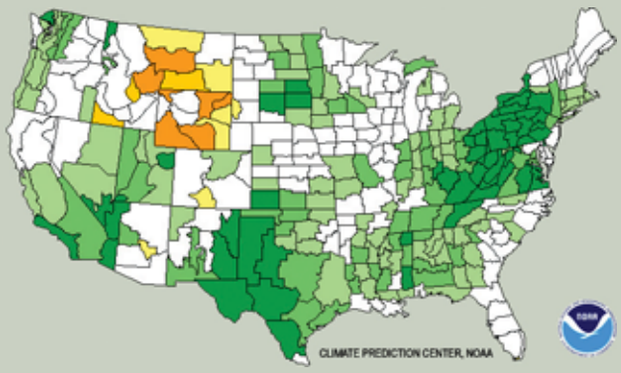


Figure 3: Drought Severity Index by Division - weekly value for period ending 20 Nov. 2004 - Long Term Palmer

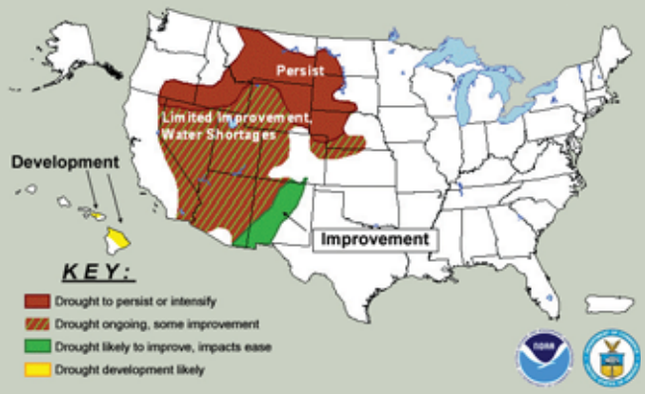


Figure 4: US Seasonal Drought Outlook - through Feb. 2005 - released November 18, 2004

On-line products from US National Drought Monitoring Centre http://www.drought.unl.edu/dm/current.html

At European scale the EU lags behind other industrialized countries with respect to drought policies, planning and operational aspects.

[13] See Annex 1.

In the USA, a national Drought Policy sets the framework within which individual states develop and implement Drought Plans. There are integrated US national drought forecasting and monitoring activities, which provide real time information to states and sectoral interests for local enhancement.

This process has produced a significant improvement in drought preparedness at state level through benchmarking and sharing of best practices. At national level, improved drought analysis and response tools have been developed, spurred on by more informed demands from the states and sectors. Similar national Drought Policies have recently been adopted in Australia and South Africa, with responsibility for development and implementation of Drought Plans at state level.

Pan-European forecasting and monitoring

Reducing the economic, social and environmental impact of droughts requires reliable and useable information to be provided to policy makers, water managers and citizens.

Research projects within the EU's 4th and 5th Framework Programmes[14] have developed and demonstrated tools for drought monitoring across the EU. Prototype communication tools have delivered this information through open access web portals. These are now being taken forward through a European Drought Centre – a virtual centre for research coordination, and training of drought managers.

Other European web portals currently provide a range of information on conditions relating to drought extent and severity. Much can be gained by capitalizing on and adapting international multi-sectoral best practice approaches to minimize drought impacts and by the development of more generic decision support systems. Recent droughts in the Mediterranean region has led to a number of initiatives including:

- WMO initiatives to establish drought early warning systems (in particular the Lisbon seminar of September 2000[15]),
- MED-HYCOS (Mediterranean Hydrological Cycle Observing System), has established a network of national hydrological services from 20 countries using of METEOSAT data,
- The INTERREG IIIb, MEDOCC "SEDEMED" project will continue the work started under the INTERREG IIc project "Assetto del territorio e lotta contro la siccità" (1999-2001) which produced hydro-meteorological monitoring systems and the drought bulletins. SEDEMED will see the participation of various environmental public institutions, administrations and universities,
- The Drought Information Network established after the "FAO-EC Expert Consultation and Workshop", held in Aleppo, May 2001,
- A Mediterranean Network on Management Strategies to Mitigate Drought promoted at the CIHEAM will set up a National Drought Observatory and
- The JRC Institute for Environment and Sustainability is currently studying the potential for drought monitoring in the regions covered by its LISFLOOD system.

[14] See Annex 1.

[15] Wilhite et .al., "Early Warning Systems for Drought Preparedness and Management", WMO, Geneva, 2000.

These actions on drought forecasting, monitoring and mitigation in the Mediterranean region need to be developed and extended to other parts of Europe. Coordinated action is required to bring these resources together and strengthen Europe's resilience to future droughts at the river basin, national and EU level.

A European Drought Network (EDN) should be established to provide policymakers, regulators and citizens with the best available information and tools to enable them to make informed decisions. Such a Network should:

- Be modeled upon the US Drought Mitigation Centre, but develop the organization to suit European geo-political realities. The EDN would collect hydrometeorological data from member states and collate this into European-scale information products.
- Include its own dedicated research programme to enable the development of continuously improved drought mitigation information products.
- Facilitate the exchange of best practice in drought mitigation measures between member states and international centres of excellence, and provide a focus for training and exchange of researchers, practitioners and stakeholders.
- Provide real time information on drought forecasts, and conditions across the enlarged EU.
- Build upon existing member state drought/water resource information dissemination activities with the aim of delivering appropriate outputs at catchment, national and EU scales.
- Include representatives of key user groups (agriculture, energy, transport, etc) to ensure that operational outputs are optimized to meet the needs of end-users.

Involving citizens

A framework for European drought mitigation must set out to change the focus from crisis management to risk management. In order to meet the climate

driven challenges of the future, greater emphasis will need to be placed upon stakeholder participatory methods in planning and decision making with respect to water resources. Measures are required to enable and encourage citizens to adopt "drought aware" lifestyles. Such measures need to influence a wide range of citizens' water use decisions (purchasing, home, work, leisure). Education has a primary role to play in establishing equitable and sustainable strategies for combating drought stress.

8. Preparing for future European droughts

In addition to policy initiatives, strengthening Europe's resilience to droughts will require investments in monitoring, research, technology transfer and education.

Research is required to underpin the development of improved understanding of the complex inter-relationships between physical, social, economic and political processes which contribute to policy, technical and non-technical measures to reduce Europe's vulnerability to droughts.

Policy Research

- Studies to assist development of a European Drought Policy, building upon international best practice, utilizing the strengths of the WFD, and relevant to the needs of the enlarged EU.
- Studies across a wide range of policy areas (agriculture, energy, tourism, etc) to optimize drought definition, mitigation and preparedness; and coherence of policy measures.
- Benchmarking Drought Plans to improve the effectiveness of mitigation measures through coordination of member state actions.

Socio-Economic Research

- Studies to develop a standard methodology for estimating economic, social and environmental cost of damage due to droughts is required.

Physical Sciences

- Research to improve the accuracy of climate models, and in particular, predictions of the spatial extent, severity and duration of drought events in the medium and long term. Coupling meteo-climatological and hydrological models to support integrated planning and decision making processes at European, national and river basin levels.
- Improved understanding of drought processes, interactions and impacts.

- Research on drought tolerant crops, the use of non-conventional water resources and more efficient irrigation and desalination technologies.
- Improved understanding of how to effectively reconcile appropriate needs with infrastructure, and social and environmental aspirations.

Risk Management Approaches

- Improve integrated water resource management systems, underpinned by process studies and appropriate remote sensing technologies, which deliver sustainable conjunctive surface and groundwater abstractions, and preservation of ecosystems.
- Process, statistical and operational systems research to develop improved criteria and tools to identify the onset of droughts, leading to improved systems which "trigger" different levels of response according to levels of drought severity at EU and state level.
- Research into the risk management aspects of drought management – supporting the needs for more pro-active (risk management) approaches rather than reactive (crisis management), requiring the use of all parts of the disaster management cycle including better public awareness procedures.

Technologies

- Research into the integration of all available instruments (policy, regulation, financial, technologies, public awareness, etc) to improve water efficiency in industrial, domestic and agricultural water use.
- Research into measures at the European level to improve the cost effective allocation and distribution of water.

Political Science Research and the Role of Citizens

- Political science research to improve communication and decision making processes between water managers, stakeholders at all levels, and politicians. These studies should cover water scarcity isues both within the EU and the impact of EU policies elsewhere in the world.

Technology Transfer, Communication and Education

- Measures are required to improve the linkages between European researchers, operational water management agencies and policymakers to ensure current operational best practice is shared between water resource policymakers, managers and stakeholders.

9. Conclusion

This Discussion Document seeks to raise the profile of droughts as a major and frequent natural disaster threatening Europe. It shows that droughts can affect large areas, over a long period of time, and result in large economic and social costs. It highlights general deficiencies in European policies in respect to drought, and calls for policy integration around a specific European Drought Policy. The Discussion Document identifies the EU Water Framework Directive as the optimum route for development and implementation of a European Drought Policy. The Document recommends that this policy adopts a risk management approach, with emphasis given to demand management, through informing and involving European citizens. The Document highlights several areas where Europe is lagging behind other industrialized nations in drought forecasting, monitoring and mitigation and points to possible ways forward. It concludes by mapping out the range of areas where improvements to drought mitigation need to be developed through research, training and demonstration.

In launching this Discussion Document the EurAqua Network not only hopes to stimulate discussion, but also to promote actions to reduce the cost of future European droughts.

For more information about this Document, and the EurAqua Network, please contact

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EurAqua was formed in 1992 to promote freshwater research at European level. EurAqua Members are drawn from every Member State and can therefore provide a comprehensive overview of freshwater priorities at national and EU level. EurAqua holds scientific and technical reviews to address current European issues, has programmes to improve the integration of European research activities, and lobbies decision-makers on topics of concern to European society.

Annex 1

Recent research projects related to European droughts

ARIDE

Assessment of the Regional Impact of Droughts in Europe - www.hydrology.uni-freiburg.de/forsch/aride/navigation/about/about.htm

ASTHyDA

Analysis, Synthesis and Transfer of Knowledge and Tools on Hydrological Droughts Assessment through a European Network - www.geofysikk.uio.no/drought/

AVEC

Integrated Assessment of Vulnerable Ecosystems under Global Change. A workshop on Vulnerability of European ecosystems facing an increased drought risk Held in Samos, Greece, 10 - 12April 2003 - www.pik-potsdam.de/avec/avec_droughts.html

CLIMAGRImed

Mediterranean Component of the FAOCLIMAGRI project-www.fao.org/sd/climagrimed/c_4_01.html

FRIEND

Flow Regimes from International Experimental Network Data. A contribution to the UNESCO International Hydrological Programme (IHP) - www.nwl.ac.uk/ih/www/research/bfriend.html

MICE

Modelling the Impacts of Climate Extremes - www.cru.uea.ac.uk/cru/projects/mice/

MITCH

Mitigation of Climate Induced Natural Hazards - www.mitch-ec.net/default.htm

WAM-ME

Water resources management under drought conditions: criteria and tools for conjunctive use of conventional and marginal waters in Mediterranean regions - www.dica.unict.it/users/fvaglias/WamMeWeb/index.htm

DSS-DROUGHT

A Decision Support System for Mitigation of Drought Impacts in Mediterranean Region – particularly in relation to management of irrigation systems - www.medaqua.org/forum/DSS-DROUGHT.html

MEDROPLAN

Mediterranean Drought Preparedness and Mitigation Planning - www.iamz.ciheam.org

Annex 2

Other Useful References / Links to droughts

Australia's National Drought Policy. Dept of Agriculture, Fisheries and Forestry - www.affa.gov.au/content/output.cfm?&OBJECTID=D2C48F86-BA1A-11A1-A2200060B0A06258

COPA-COGECA (2003). Assessment of the impact of the heat wave and drought of the summer 2003 on agriculture and forestry. Committee of Agricultural Organisations in the European Union / General Confederation of Agricultural Co-operatives in the European Union. Fact Sheet. 14p - www.copa-cogeca.be/pdf/pocc_03_78i4_1e.pdf

EurAqua (1996). A review of European flood and drought mitigation measures. 6th EurAqua Science and Technological Review, Rome October 1996.

European Environment Agency (2004). Mapping the impacts of recent natural disasters and technological accidents in Europe. Environmental issue report No.35. European Environment Agency, Copenhagen - http://reports.eea.eu.int/environmental_issue_report_2004_35/en

Glinni, A.F., Sivakumar, M.V.K., and Wilhite, D.A. (2001). Drought management and preparedness – WMO perspective. Paper presented at the MITCH (Mitigation of Climate Induced Natural Hazards) Workshop, 12-13 December 2001. WL Delft Hydraulics, Delft, The Netherlands. 15p - www.mitch-ec.net/papers/glinni.pdf

Hisdal, H., Stahl, K., Tallaksen, L.M. & Demuth, S. 2001. Have droughts in Europe become more severe or frequent? International Journal of Climatology, 21, 317-333

Lehner, B and Dill, P. (2001). Eurowasser: Europe's droughts today and in the future. Chpt 7 p7-1 to 7-16, in : EuroWasser - Model-based assessment of European water resources and hydrology in the face of global change. Kassel World Water Series 5 - www.usf.uni-kassel.de/usf/archiv/dokumente/kwws/kwws.5.en.htm

Rossi, G., Cancelliere, A., Pereira, L., and Oweis, T. (eds) (2003). Tools for Drought Mitigation in Mediterranean Region, Kluwer.

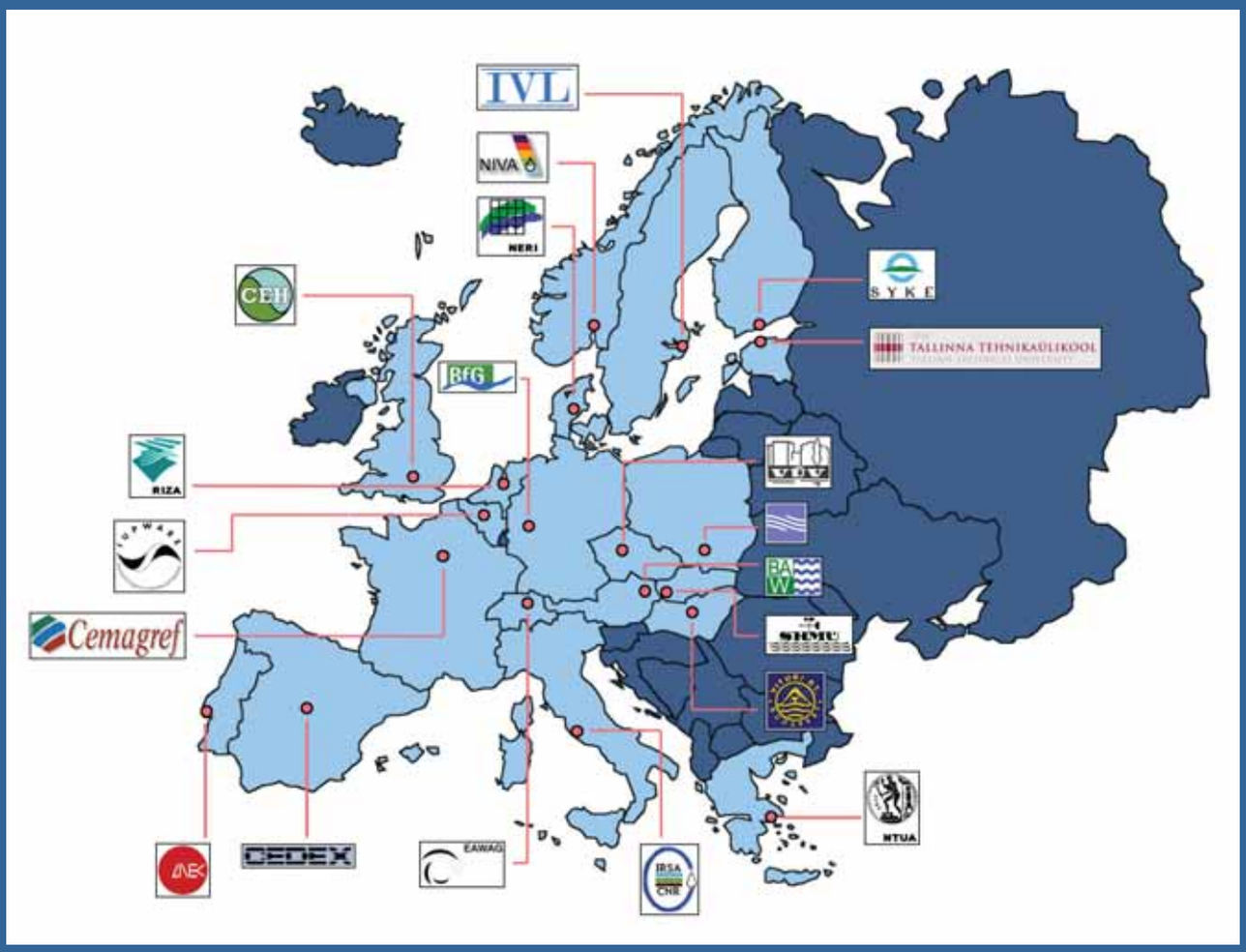
SEDEMED Hydrometeorological monitoring systems and drought bulletins for use by environmental public institutions, administrations and universities - www.uirsicilia.it/progetti/sedemed/intro_sedemed.html

UNEP, 2003. Impacts of summer 2003 heat wave in Europe. DEWA/Europe/GRID- Geneva - www.grid.unep.ch/activities/earlywarning/preview/appl/climatic/images/heatwave_en.pdf

USA National Drought Monitoring Centre - http://drought.unl.edu/dm/

USA National Drought Mitigation Centre - http://drought.unl.edu/

The EurAqua Network of European Freshwater Research Organisations



EurAqua aims to contribute substantially to the development of European freshwater science and its dissemination on a European scale, thus having a significant input on the development of the scientific basis of European water management