DROUGHT: COULD TODAY'S HAZARD BECOME TOMORROW'S NORM?

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ABSTRACT. - Drought: Could Today's Hazard Become Tomorrow's Norm? Extreme drought events today could become normal conditions in the future. Climate change in southeastern Europe portends warmer and drier conditions. Thus contemporary drought may well exemplify conditions that will become the climate normal in the future. The case of drought in Bulgaria illustrates issues related to this observation.

Introduction

That disasters resulting from "natural hazards" constitute a conjunction of extreme geophysical events with human vulnerability is now widely recognized (Hewitt 1983). Some events are largely self-imposed, when individuals and societies develop vulnerable places such as floodplains, unstable landforms or coastal areas. All these areas are known to have inherent dynamic geophysical instability. Other events, such as drought, inevitably have impacts on a wider population whose culpability in creating vulnerability is arguable. Even here, one could reason that society learns that climate is variable, and by extending itself into drought prone areas with technologies that are not yet resilient, society again contributes to vulnerability. Through time, society learns to cope with recurrent drought by strategic decisions that may involve land use (land rotation, transhumance), technologies (drought-resistant crops, irrigation), social insurance (multi-year food storage, subsidies to occupants of marginal areas, famine relief), and long-term regional development trajectories (water resource supplies, infrastructure development).

The climate during a two-decade long drought in Bulgaria (1982 to 1994) was alarming like climate change projections for the future century. A team of Bulgarian and international scholars developed a project to examine the impacts of this drought with the intention that it might serve as an analog for future climate. The team concluded in a recently published book (Raev et al. 2003; Knight et al. 2004) that we can learn about planning for future climate from today's drought. Indeed, today's drought hazard may become tomorrow's climate norm in the Bulgarian part of the Balkans.

In this brief paper, we draw on this book (in Bulgarian, forthcoming in English) on the Bulgarian drought as an analogy of climate change. We begin by describing the drought and some of its major consequences. We then turn to the issue of the drought event versus future climate, suggesting that future climate

normal may be like today's extreme drought conditions. We outline what we have learned about the drought in light of future climate, with attention to the drought itself, to using drought as an analog, and to recommendations to policy makers. We conclude by highlighting some of the lessons learned and challenges of turning these lessons into productive policy.

The Bulgarian Drought

Drought has been no stranger to Bulgaria. Closely linked to the North Atlantic Oscillation and to changes in Atlantic and Mediterranean storm tracks as well as to persistent blocking anticyclones, drought has reoccurred in Bulgaria throughout the period of meteorological records. A cultural focus on drought in rituals, folk songs, poems and literature, some extending as far back as the Thracian era, suggests that drought has continuously plagued human society in this region.

By some accounts, Bulgaria should be naturally endowed with ample water resources. These accounts, however, depend on the dubious allocation of water in international rivers to all countries through which they flow. Give Bulgaria all 200 km^3 of Danube water for its 8 million inhabitants, and it appears that water should be no problem. Given the energy costs, geography, transportation threat, and ecological damage that could be wrought by Bulgaria taking massive water from the Danube, doing so is an impossibility. Thus Bulgaria must largely make due with its average 670 mm average annual precipitation and its 20 km^3 average annual river flow. Even the latter figure is constrained by Bulgaria's contribution to the Danube along the Bulgarian-Romanian boundary and to flows into Greece and Turkey which are vital for these countries.

The climate and water resources of Bulgaria are strongly influenced by geography and topography. Lowland precipitation barely reaches 500mm in the northeast and the Thracian Plain of the Maritsa River; it is only the orographic effect of the mountains and especially winter snow accumulation that drives the country's hydrology. The climate of the southwestern fringe of Bulgaria is transitional from Mediterranean to continental; the bulk of the nation has a continental climate.

The most recent continuous drought in Bulgaria emerged in 1982 and increased with minor interruption through 1994. For various parts of the country, 1992, 1993 or 1994 was the driest year on record. The drought period broke in 1995, but several subsequent years have been abnormally dry, although not in succession. Current water planning in Bulgaria calls for building tens of additional high dams at a time when dam-building is viewed in skepticism over much of the globe. The relatively dry conditions of Bulgaria are illustrated by the observation that only twice since its construction in the 1950s had the Iskar (former Stalin) Reservoir serving Sofia been filled by the time of the drought under consideration. Given the impossibility of using reservoirs to store water over decade-long periods, it is realistic to question whether enough runoff during future drought (or under climate norms like today's drought) would be available to fill the planned reservoirs.

As the drought began to emerge in the 1980s, impacts were felt across many natural and human phenomena. Among the earliest of these impacts were declines in forest growth, reduced river flow, and the beginnings of a downward trend in hydroelectric power production that would continue until 1995. Through 1989, the Bulgarian economy was highly water intensive. Ten percent of the total land area of the country was under irrigation, and this water use along with industrial and potable water supply summed to as much as the total flow of streams in the peak drought years to follow. The collapse of industry and a large portion of the irrigated agricultural areas immensely decreased water withdrawals by 1993-1994; elsewhere we argued that /had the 'transition' not taken place prior to this period, the drought would have been truly a national calamity (Knight et al. 199x). By the 1990s, drought impacts were being felt strongly in agriculture, planted forests, water supply, the economy, human health, and even the political sphere.

In agriculture, falling yields cost Bulgaria $100s of millions. Natural forests were adapted to periodic drought and suffered little, but planted forests were severely affected, especially pine forests planted in areas on average much warmer and drier than their natural habitat. Forest fires multiplied, especially in planted forests.

Bulgaria justifiably took pride in the extent and quality of its potable water supply, but the drought severely challenged what had been accomplished. As reservoirs were depleted to levels below conservation pools and sediments were stirred into potable water withdrawals, water quality deteriorated. Water rationing, in Bulgaria referred to as a 'regime' with interrupted flow, spread from some cities and localities with seasonal water shortages to major urban areas and the capital. At its crisis peak in late 1994 and early 1995, some areas of Sofia had water one day in four. A combination of the on-off regime, resulting damage to old asbestos-cement pipes, leakage into as well as out of the distribution system, and failure of treatment, Shigellosis dysentery and hepatitis outbreaks were widespread. No "boil water" warnings were given, and surprisingly, there was little done to conserve water other than turn off supplies.

Drought affected the economy through falling crop yields, the need to import foodstuffs, increasing energy costs due to lower hydroelectric production, and indirectly through the interruption of the normal functions of civil society trying to cope with lack of water for basic human needs—time taken to store water when it was available, to travel to natural springs and wait through the crowds of others also collecting pure water, and to travel to friends and relatives in other quarters with water for basic sanitary needs. It has proven difficult to sort drought impacts on economy from other issues contributing to national accounts, but that the drought exacerbated the already strained economic conditions is certain.

The drought entered into the public sphere in several ways. The reward for the director of the National Water Council for warning of the impending crisis was to be fired. The media were active in citing this and experts variously blamed the emerging crisis on mismanagement, poor measurement, water leaks, water theft,

and to derivation of water to industry and hydro power versus meeting potable water needs. In the end, all of these were contributing factors, particularly the use of water for hydropower generation at times when downstream multiple use was least optimal. At the same time, the national government restarted implementation of an interbasin water transfer project that had been started prior to 1989 but abandoned as part of the Ecoglasnost agenda that contributed to the fall of communism in that year. Protests and blockades by villagers in the source region were ultimately met by violent police action; the government never made good its commitment to that region to safeguard their water supply and build a local reservoir for supply improvement. This was a severe test of the emerging democracy that showed clearly that a national mindsetfavoring centralized command and control did not die with formal communism. The author of a chapter on this protest termed it Bulgaria's first "Post-1989 Water War" (Staddon 2004).

Why the Drought is Important in Light of Future Climate

The twelve-year drought in Bulgaria is unsurprising from the viewpoint of droughts in other places and other times, except perhaps for its persistence. In itself, the drought should be motivation for scientific and social research leading to policy and management changes in the face of similar future challenges. But the picture may be more bleak. We can prognosticate with great certainty that given the cyclical nature of drought in Bulgaria's past, such a drought will happen again, assuming continuation of historical climate processes. Water resources and climate in this region are tenuous. But climate is not static; every evidence points to human-induced change of climate. Bulgaria, among nations in the Balkans, contribute to climate change through greenhouse gas emissions, much as these emissions have been reduced since 1989 through the collapse of industry.

Thus our team turned to some climate projections for the future of the region, paying attention not so much to details as to general trends of change that are quite consistent among climate change models. Using baseline and climate change data bases from the Intergovernmental Panel on Climate Change's Data Distribution Center (IPCC-DDC) at the University of East Anglia, we compared the 1961-1990 climate normals and individual drought years, such as 1993, with projected climate normals in the future under two major climate change scenarios from the Canadian Climate Centre and the United Kingdom Hadley Centre. Projections from the latter were downscaled to a grid comparable to the 0.5 by 0.5 degree normal period using change surfaces interpolated using an inverse distance weighting function across the wider regional grid of climate change models. Precipitation (P) change was based on percentage; temperature (T) change was based on absolute change. From this data we derived estimations of potential evapotranspiration (PE) using the method of Blaney and Criddle, since that method replicated well the established pattern of PE across Bulgaria (Steuer and Knight 2004; USSCS 1970).

Figure 1 shows the geographical pattern of P, PE, and annual P-PE across Bulgaria during the 1961-1990 period, and P-PE for the drought year 1993. In the

figures it is easy to discern the east-west Stara Planina Mountains as well as the mountain blocks of the south and southwest of the country by higher precipitation, lower temperature and positive values of P-PE. 1993 was clearly drier than the normals by a substantial amount.

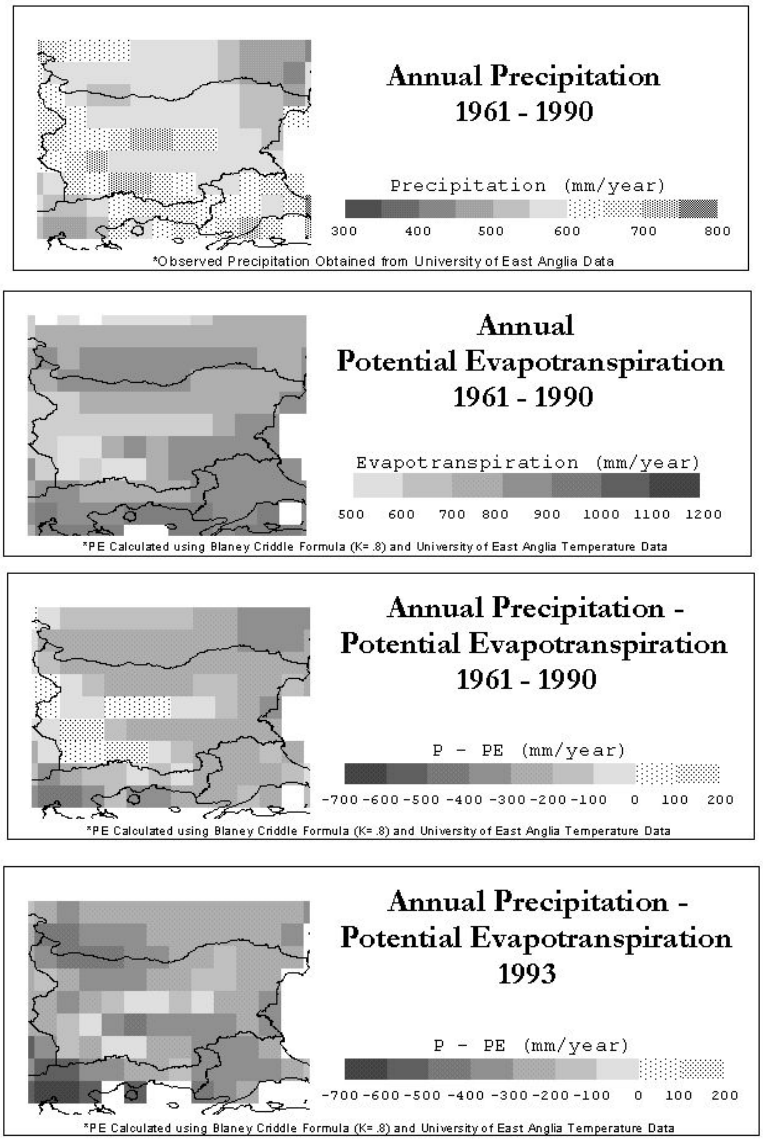

Figure 1. Bulgarian Climate Normals and the Drought Year 1993 (after Steuer and Knight 2004). The high mountain areas generate surplus runoff. The 1993 drought was particularly marked in western Bulgaria.

Given projections that Bulgaria will have marginally more precipitation earlier in the 21st century then eventually less precipitation toward century's end, and that Bulgaria will warm substantially throughout, it is not surprising that warming dominates with conditions throughout the century becoming increasingly drier than the 1961-1990 normals. Figure 2 compares the 30-year period centered on 2085 with the conditions a century earlier using the Canadian and UK models, using annual P-PE as a comparative measure.

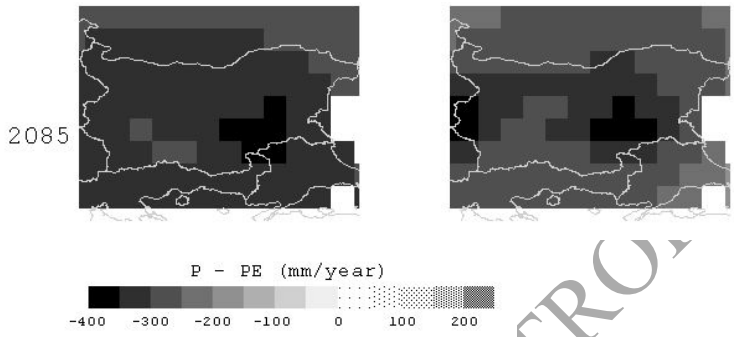

Figure 2. Changes in Mean P – PE Compared to 1961-1990 Climate by 2085 Under Two Climate Change Scenarios (Canadian Climate Centre, left, and UK-Hadley Centre, right). The whole country is significantly drier than the base climate (after Steuer and Knight 2004)

What is particularly disturbing is that the projected conditions for 2085 appear for Bulgaria to be as dry or drier than even the drought years, exemplified by comparing 1993 with the future 2085 scenarios, again using P-PE in Figure 3. The eastern two-thirds of Bulgaria will be drier on average than the drought year 1993; the western third will be at least as dry, according to these scenarios.

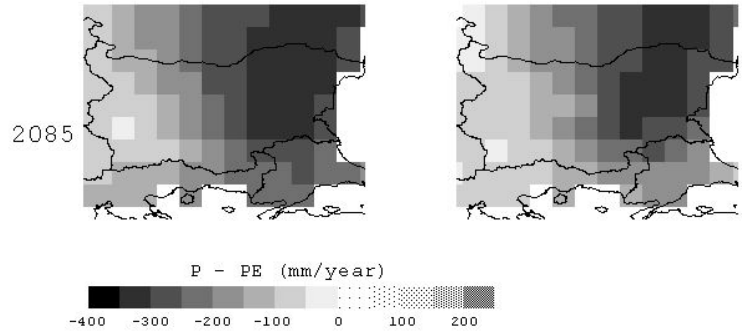

Figure 3. Changes in P – PE Compared to 1993 Climate by 2085 Under Two Climate Change Scenarios (Canadian Climate Centre, left, and UK-Hadley Centre, right). Nowhere in Bulgaria is on average wetter than the drought year 1993 (after Steuer and Knight 2004)

We do not offer these scenarios as a prediction of Bulgaria's climate. We hope that the international community will be willing to take decisive action to prevent such climate change occurring. Even if this fails, climate scenarios are just that, scenarios. What was important in motivating our research team, however, was the *possibility* that future climate could be as threatening *on average* as the extreme drought that had actually occurred.

What We Have Learned from the Drought

What we have learned from the drought can be expressed in three ways: what the drought taught us about the challenges of future climate; how the strategy of analogy helps in examining climate change; and what recommendations we offer to decision makers based on our analyses.

If future climate is like the drought years, we see significant challenges to natural resources, water, agriculture, forestry, human health, economy, and civil society. Forests and wildlife, adapted to the variability of today's climate may be threatened by the warmer and drier conditions that become a future norm, particularly if similar variability around that norm occurs in future as it does today (there is no evidence to suggest whether variability will be greater or less than today). Misplaced artificial forests may be devastated in future, and agriculture severely challenged, particularly in the absence of a functioning irrigation system. Even if such a system is in place and functioning, there may not be enough water to satisfy irrigation, industrial, hydropower, and potable water needs. Without strong public health initiatives, human wellbeing will certainly be threatened. An economy designed around today's environmental conditions, and particularly today's water availability, may not be viable. Impacts expressed in the media, in public decision making, and in civil society could be anticipated.

About analogies, we did not try to create a picture of Bulgaria in the future where today's drought is tomorrow's norm. But the team did suggest that thinking about the future using drought as an analog was useful and productive. The climate events of the drought were real and in contemporary time; thus viewing this climate and society as somewhat analogous to a future seemed reasonable and appropriate. Most importantly, the drought as experienced by the living community provides a useful way to suggest a future beyond contemporary lifetimes.

The team completed the book with fifty recommendations to policymakers. These recommendations ranged from admonitions for the development of a fully integrated assessment of future climate change impacts on Bulgarian society to noting the urgency of incorporating the potentials of climate change in all aspects of planning. For example, normals and statistical distributions of past runoff may not accurately reflect hydrological perspectives needed for future water resource planning. There were recommendations in all areas, from natural resource management to artificial forest planting, agriculture, pest management, economic planning, human health, and in public education and awareness.

Conclusions

The lessons of the Bulgarian drought have great relevance for future climate change. Clearly not all years in the future will be as dry as the 1982-1994 drought, but if mean climate conditions are similar to the drought period, then surely some years may even be worse. It would seem crucial for future planning to look beyond climate normals to variability around mean conditions, and to plan for scenarios of extended drought severity even greater than those experienced at the end of the last century.

Perhaps the most important lesson of the drought study in Bulgaria is that contemporary events provide important and realistic lessons for future planning. There will be great challenges, however, in encouraging application of what is learned. The time framework spans several human generations; adaptation may challenge conventional wisdom and practice; and cultural and political inertia may weigh heavily. As one political leader in Bulgaria exclaimed, "How can scientists get politicians to pay attention to challenges decades ahead when their focus is only through the next election?"

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