Flash Flooding in Attika, Greece: Climatic Change or Urbanization?

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FLOODING RECORDS IN ATTIKA

Flooding constituted the second most frequent natural disaster in Greece during 1928–2005 (15 episodes; 23.4% of total) after earthquakes; it led to 78 deaths, 10,990 affected people and 719,518,000 US\$ damage and repair costs (World Health Organisation 2005). Nevertheless, the 28 episodes of flooding in Attika Prefecture (Fig. 1) cost more human lives (182 people) during the last century (1887–2005) than earthquakes (18 people) while the cost in human lives due to flooding for the whole country during the same period was 220 people (Nicolaidou and Hadjichristou 1995; Lasda 2005).¹

LAND USE AND HYDROGRAPHIC CHANGES

Two events exerted significant influence on Attika's population during the twentieth century: the Minor Asia emigration in 1922, which led to the entry of thousands of refugees to Attika, and the internal migration to the capital of Greece that followed the end of World War II. The Attika basin gathered only an 18% (1,394,922 people) of Greece's population in 1951, which reached a 35% (3,062,278 people) in 1981. The population of Attika basin tripled during 1940–2001 (188.8% increase, 3,292,189 people) (Greek National Statistics Service 2001).

The influx of people at the 3,808 km² Attika basin boosted construction activities. Thus, Attika's urbanized area increased from 17.7% in 1945 to 39.6% in 1973 and to

68.5% in 1995 (Sioras 2003). The increase in urbanized area led to concomitant decrease in cumulative cultivated, forested and shrub areas (cumulative percent area cover was 81.3% in 1945; 42.5% in 1973; 31.0% in 1995). The development paradigm followed for several decades lacked organization and wisdom leading to congestion and over-use of natural resources in urban areas of Attika. Human interference at suburban areas of Attika included land clearance, agricultural abandonment, forest fires, unplanned expansion of urban areas, and rubble-filing for the creation of roads and plots.

Dramatic were also the gradual changes in the hydrographic network of Attika, which led to the reduction of the total length of its active branches. This reduction had started already since 1893–1945 (from 1,277 to 858 km, 33.6% reduction), continued during 1945–1973 (from 858 to 734 km, 14.5% reduction) and culminated during 1973–1995 (from 734 to 434 km, 40.9% reduction) (Sioras 2003). Thus, there was a 66.4% reduction in the hydrographic network during 1893–1995 while the ratio of active to inactive streams was 0.5 in 1995. The evolution of the state of the hydrographic network may be pictured as small and large streams being covered or modified, totally or partially with construction works of various types and scales within their watercourse (but mostly at their banks) and being inflicted upon with trespasses and unauthorized construction (Bitsika 2003). Some streams were modified or blocked in order to avoid unpleasant consequences, such as flash floods or stench. Construction on top of, modification, and blockage of streams were identified, however, as modernization and a trend of discarding what was

¹ Missing data during periods 1885–1895, 1897–1920, 1950–1960, and 1962–1972 in references Nicolaidou and Hadjichristou 1995 and Lasda 2005.

Fig. 1 Map of Attika Prefecture in Greece

related to the past, the under-development and the low standards of living. Furthermore, solid waste discard in streams became a usual phenomenon leading to the creation of pollution foci, which are hazardous to public health, and reduction of the channeling of active streams (Sioras 2003).

The aforementioned changes in land use and hydro-graphic network led to reduction in the infiltration of water and the enrichment capacity of the aquatic resources and to increase in erosion, surface runoff and locality-specific vulnerability to flash flooding depending on distance from streams and slope of land at Attika basin (Sioras 2003; Tsakiris 2004; Mimikou 2005; Ministry of Planning, Public Works and Environment 2005).

CLIMATIC CHANGE

Global climate change induced by increased greenhouse gas concentrations has been widely recognized and is often cited as involving changes in temperature and precipitation patterns. Precipitation exhibited significant declining trends in higher latitude regions in the Northern Hemisphere given precipitation records of the last century (Dore 2005). While countries of northern Europe have experienced increase in precipitation during the last decades, countries

of south Europe bordering the Mediterranean Sea (including Greece) have experienced reduction in precipitation (Tsiourtis 2002). Time series analysis of precipitation in Athens during 1925–1999 revealed a decreasing (by 10%), yet, not significant trend (Feidas and Lalas 2000).

Nevertheless, the flash flooding episodes of the 8th July, 3rd August and 18th August 2002 in Attika have been attributed to extreme, for the summer season, rainfall intensities (Bitsika and Tratsa 2002). The rainfall monitoring station at Thisio recorded 91, 56 and 48 mm of rainfall during 24 h, respectively, during the aforementioned flash flooding episodes while the rainfall monitoring station at N. Philadelphia recorded a summer mean rainfall of 10 mm during 24 h and only one rainfall episode exceeding 40 mm during 24 h for the period 1970–1997. Also, the flash flooding episode of the 21st–22nd October 1994 in Attika has been attributed to extreme rainfall intensities reaching 42.7 mm during 24 h at N. Philadelphia rainfall monitoring station and having turnover time larger than 500 years (Mimikou and Koustoyannis 1995; Xanthopoulos et al. 1995).

Application of the Precis model at eastern Mediterranean predicted decrease in the mean monthly rainfall and in the number of days with rain for all months of the year at Athens during the period 2071–2100 (Kotroni et al. 2005). Also, results of the application of four regional climatic

change models (HadCM2, Hadley Centre for Climate Prediction and Research; CCCma, Canadian Centre for Climate Modelling and Analysis; LMD, Laboratoire de Meteorologie, France; and DKRZ, Deutsches Klimarechenzentrum, Germany) point to Athens as one of the localities in eastern Mediterranean experiencing the largest decrease in rainfall till 2050 (Feidas and Lalas 2000). Furthermore, there is expected higher frequency of droughts in localities that will exhibit the largest decrease in rainfall since the likelihood of drought days and their duration will increase; such indications are already apparent in Attika (Feidas and Lalas 2000). It seems, then, that Attika exhibits increased vulnerability to both droughts and floods due to climate change.

FLOODING MANAGEMENT

Under the name “Xenocrates,” a general plan exists for the prevention, mitigation, and control of natural hazards including floods (Koutsoyiannis and Mimikou 1996). This plan constitutes a guide for collaboration and coordination of the authorities and public services organizations, which are involved in the control of emergency situations. The plan includes measures in both the central and local level. The authorities of the central level, i.e., ministries, are responsible for the general planning and coordination. The authorities of the local level (Prefectures, Municipalities, Communities) are responsible for the actions taken for prevention, e.g., inspection and maintenance of flood protection works, control (readiness both in equipment and personnel), and restitution (assessment, reporting, compensation) of damages.

Pre-emergency measures are focused mainly on the construction of flood protection works, such as levies and channel modifications, rather than forecasting and decision making. Attention has been given to flood forecasting for the protection of dams during construction and for the avoidance of dam failure, however (Koutsoyiannis and Mimikou 1996). Yet, flood protection works in Attika have been repeatedly characterized as obsolete based on archaic data; inadequate to keep up with urbanization levels; faulty (positioned upstream instead of downstream), relocating flooding vulnerability to other localities within Attika; lacking proper operation and maintenance due to administrative confusion (Ministry of Planning, Public Works and Environment, Athens Water Supply and Sewerage Company (EYDAP SA), regional and local government bodies); fragmented aiming to cover urgent needs or to protect new road works; and, in some cases, incomplete (Mimikou 2005; Xanthopoulos et al. 1995; Greek GeoTechnical Champer 2004; Kitsos 2004). Experts characterize the storm drainage network as still primitive and call

for a master plan pertaining to the flooding protection of the Attika basin, that would also integrate the climatic change challenge, and the establishment of permanent rainfall monitoring stations within the basin (Mimikou 2005; Xanthopoulos et al. 1995; Greek GeoTechnical Champer 2004).

Recurrent, contemporary flash floods at Attika are mainly due to unplanned, widespread, and rapid urbanization. The vulnerability of Attika to flash flooding is augmented because of an, as yet, spasmodic, un-coordinated, mainly reactive flood-prevention strategy, which does not take under consideration the anticipated increase in intensity and rapidity of rainfalls due to climate change at Attika basin. Management of flash floods in Attika Prefecture is further complicated due to large forest fires, such as the catastrophic forest fires of summer 2007 (BBC News 2007a, b; Kitsantonis 2007; Athens News Agency 2007), which, among others, exacerbate erosion and surface runoff.

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