

HUMAN IMPACTS ON LANDSCAPES: LESSONS OF CITIES FROM THE PAST

IMPACTOS HUMANOS NAS PAISAGENS: LIÇÕES DE CIDADES DO PASSADO

IMPACTS HUMAINS SUR LES PAYSAGES: LEÇONS DES VILLES DU PASSÉ

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ABSTRACT

The first cities emerged in the Middle East at the end of the 4th millennium BC. Studies in the field of archaeology, geomorphology, geoscience and history allow us to understand which types of hazards were affecting the cities, and how they had an impact on landscapes in the past, in the Middle East, but also in other parts of the world. There is much to be gained: these studies are fundamental to a better understanding of present-day hazards, to urban development, but also to remembering our heritage. Cities have always been susceptible to nature's risks and natural disasters but have also – through urban development and through the proximity of great numbers of human beings –, generated their own specific hazards.

Key Words: Geoarchaeology. City. Hazards. Archaeology. Environment. Urban Development. Heritage.

RESUMO

As primeiras cidades surgiram no Oriente Médio no final do 4º milênio aC. Os estudos no campo da arqueologia, geomorfologia, geociências e história permitem-nos compreender quais os tipos de perigos que afetavam as cidades e como tinham impacto nas paisagens no passado, no Médio Oriente, mas também noutras partes do mundo. Há muito a ganhar: estes estudos são fundamentais para uma melhor compreensão dos perigos da atualidade, para o desenvolvimento urbano, mas também para relembrar o nosso patrimônio. As cidades sempre foram suscetíveis aos riscos da natureza e desastres naturais, mas também - por meio do desenvolvimento urbano e da proximidade de grande número de seres humanos - geraram seus próprios perigos específicos.

Palavras-chave: Geoarqueologia Cidade. Riscos. Arqueologia. Meio Ambiente. Desenvolvimento Urbano. Patrimônio.

RESUMÉ

Les premières villes ont émergé au Moyen-Orient à la fin du 4e millénaire avant notre ère. Des études dans le domaine de l'archéologie, de la géomorphologie, des géosciences et de l'histoire nous permettent de comprendre quels types de dangers affectaient les villes et comment ils ont eu un impact sur les paysages dans le passé, au Moyen-Orient, mais aussi dans d'autres parties du monde. Il y a beaucoup à gagner: ces études sont fondamentales pour une meilleure compréhension des aléas actuels, pour le développement urbain, mais aussi pour se souvenir de notre patrimoine. Les villes ont toujours été exposées aux risques de la nature et aux catastrophes naturelles, mais elles ont également généré - grâce au développement urbain et à la proximité d'un grand nombre d'êtres humains - leurs propres risques spécifiques.

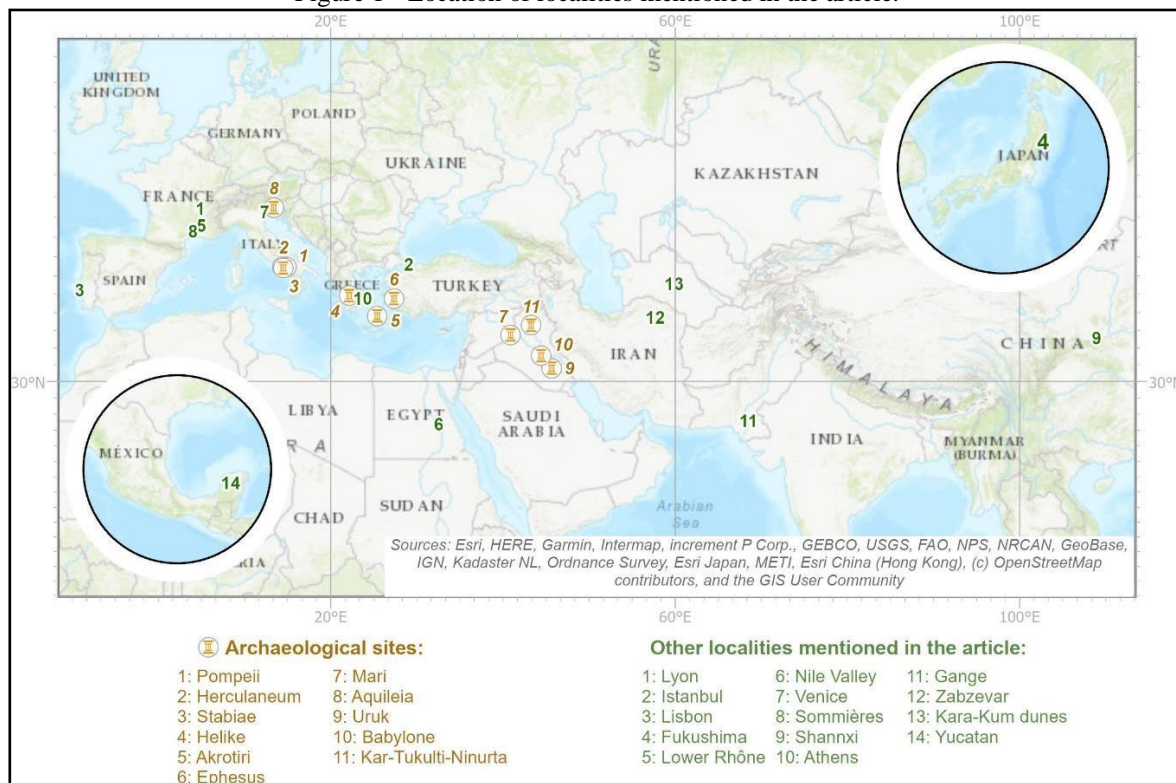
Mots clés: Géographie. Ville. Dangers. Archéologie. Environnement. Développement urbain. Patrimoine.

INTRODUÇÃO

If we see the end of the neolithization process as being around the year 6000 BC, in the Middle East first of all, then cities begin to appear after a long maturation period at the end of the 4th millennium BC (BUTTERLIN, 2010). They sprung up on the banks of large rivers in Mesopotamia, in the areas that are now Iraq, Iran and Syria; and in the valleys of the River Nile, the River Jordan, the River Indus, the River Ganges and the Yellow River. The date of their emergence in Africa, Meso-America and South America is still disputed, but is more recent ('T HART; BLOCKMANS, 2016). What distinguishes cities from villages or clusters of little farming towns is the concentration in a single area of economic, political, social and religious powers, which was reflected in a high relative concentration of non-farming populations and in

a monumental administration often enclosed within a surrounding wall (BUTTERLIN, 2010; NICOLLE, 2013).

Figure 1 - Location of localities mentioned in the article.



Source: Fouache; Desruelles (2020).

Geoarchaeology is an interdisciplinary approach that we define as being founded upon the use of methods and techniques drawn from geosciences, archaeology and geography, to recreate palaeoenvironments and landscape processes in a multi-scalar, diachronic archaeological perspective, in connection with human occupation (FOUACHE, 2010). The geo-archaeological approach allows us to comprehend the evolution of environmental processes over the course of time in an urban studies context, and the parallel evolution of the issues, the risks and thus the hazards of a city. Large modern-day developments, like the construction of an underground car-park in Lyon (Quai Saint Antoine), or the boring of tunnels in Istanbul (in the Yenikapi neighborhood; fig. 1), going under the Golden Horn and the Bosphorus to link old Stamboul to the Asian side of the city, have resulted in a proliferation of conservation-oriented archaeological excavations associated with environmental studies where ancient cities once stood; in this instance the identification of the bed of the River Saône in the early Iron Age (VOISIN, 2010), and the excavation of a 10th-11th AD Byzantine port (DEGREMONT, 2009). This is a major opportunity to bring together urban development, archaeology, and history; and to encourage understanding of environmental processes amongst urban populations by integrating the notion of heritage into this understanding (BINI *et al.*, 2018). This is of importance to the whole world, and especially to the world's major cities.

Explaining the hazards of ancient cities can also serve as a great warning to the current generation and promotes prevention policies rooted in a real understanding of the interaction between natural processes and processes brought about by human societies. We must not, however, fall into any irrational fear of the risks of our environment. Between the Bronze Age

in the Middle East, the Iron Age in Western Europe and the end of the modern era, examples of urban civilizations that have been destroyed solely by environmental disasters are rare.

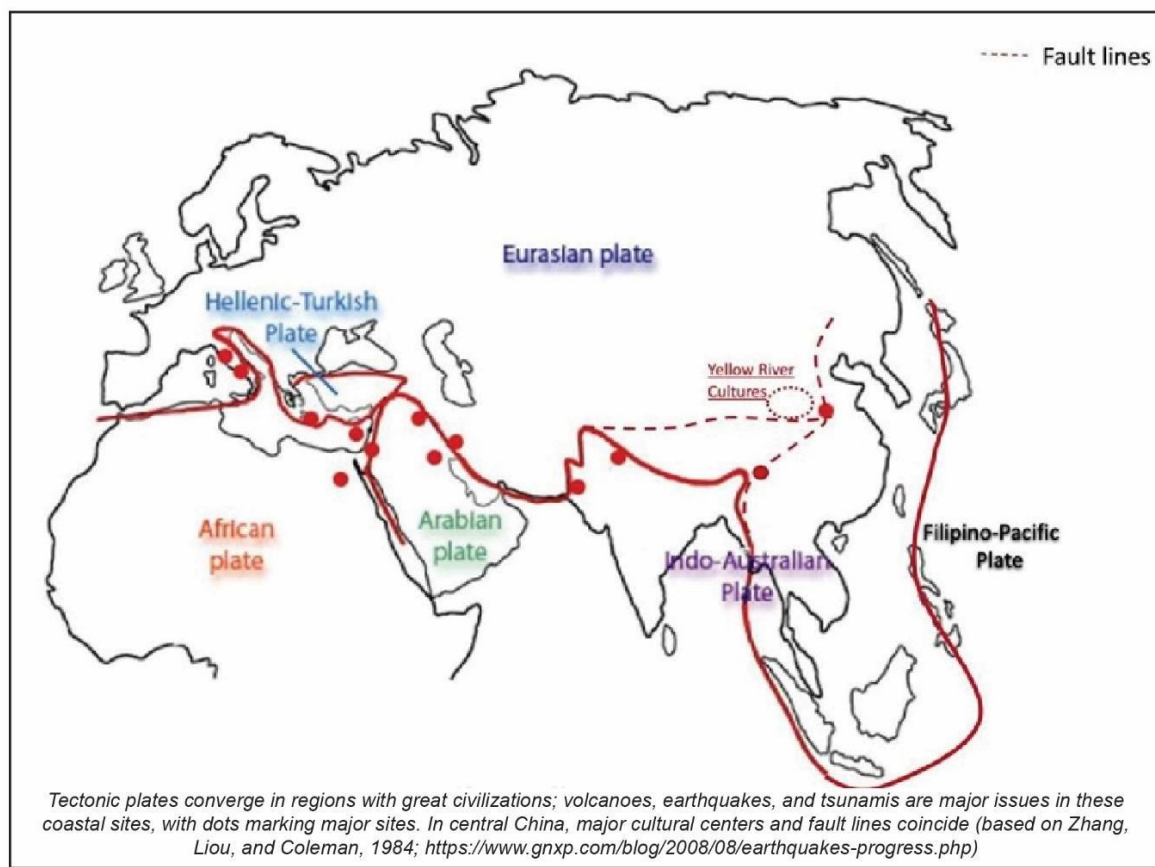
CITIES AND CATAclysms

The greatest risk for cities of the past was, of course, as today, a cataclysm, be it the direct effects of a natural disaster or the effects of society. The most notable kinds of such cataclysms are volcanic eruptions, earthquakes, and tsunamis (FOUACHE, 2006; LIRITZIS *et al.*, 2019; fig. 2). Numerous cities were erased from the map in this way: Pompeii, Herculaneum and Stabiae in Campania when Mount Vesuvius erupted in AD 79; Akrotiri in Santorini between 1635 and 1628 BC; and Helike swept into the Corinthian Gulf in 373 BC (fig. 1). The Lisbon earthquake of 1755, followed by a tsunami and the destruction of the city by the ensuing fire, is a good example of how urban development can amplify the consequences of a catastrophe (fig. 1). The Fukushima catastrophe in 2011 is yet another in this long line (fig. 1). However, it is somewhat exceptional to see a city being completely erased from the map; in the past as in the present, cities normally rise from the ashes in the same place, providing that the political and social systems possess sufficient resources to do so, and that the city is produced by the socio-economic, political and religious systems. It is due to those socio-economic, political, and/or religious imperatives that the city is rebuilt in the same place, either because of the site or because of the image of the city. A city's exposure to 'natural' hazards is not, however, limited to cataclysms.

NON-CATAclysmic NATURAL HAZARDS

The frequent location of cities on the banks of rivers (BRAVARD; MAGNY, 2002) or by the sea puts them at the mercy of dramatic rises in water levels, floods and changing shorelines (MORHANGE *et al.*, 2007). The original site of the city is often sheltered from these dangers, on a headland or hill; but as soon as the city has been established, a lower city, suburbs and a port, which are exposed, all come into existence; then, very soon after, urban growth spreads into at-risk areas, the original site being too small. An example of this is the town of Sommières in the Gard department (France; fig. 1), built at the foot of the hill on which the castle stands, right on the River Vidourle flood plain (BOULIER *et al.*, 2018) despite the high frequency of floods originating in the Cevennes rains. The enforcement of collective risk-management measures can be a factor in the social acceptance of the hazard. Thus, the Ancient Egyptians viewed the floods of the Nile (fig. 1) as a nourishment of the land, and the Venetians very quickly learnt to live with the phenomenon of *acqua alta* (fig. 1). In the Roman city of Aquileia (fig. 1), the fluvial risk was considered to be secondary to the profits (economic, strategic, political) that societies made from the exploitation and the use of the Natisso River (ARNAUD-FASSETTA *et al.*, 2010). Indeed, the site chosen can itself be the cause of a city's wealth. The ancient city of Mari (MARGUERON, 2004) on the Middle Euphrates in modern-day Syria (fig. 1) was linked to the river, its irrigated farmland, and its waterway. Throughout the third and second centuries BC, these advantages enabled a costly development that the Sumerian civilization in Uruk (fig. 1) had the human and financial resources to support. The surrounding wall of Mari's earliest settlement ("Ville I", ca. 2900-2600 BC; BURKE, 2008) is considered by Margueron (2000, 2004) as a dyke for flood protection.

Figure 2 - Plate boundaries and major cultural centres.



Source: Liritzis *et al.* (2019).

The same is true for Babylon on the Euphrates River (fig. 1), where many inscriptions found in relation to buildings mentioned flood defenses built during the reign of Nebuchadnezzar II (604–562BC) such as quay, canals, moats and dams (PEDERSÉN, 2014). In the end it was not the river's water levels that destroyed Babylon, but the Median invasion.

What geoarchaeological studies also teach us, as well as the studies of paleo-climatologists, is that at the level of the Holocene (MAYEWSKI *et al.*, 2004) – the last 10,000 years –, environmental processes have varied: the seasonal distribution of weather types, temperatures (by a yearly average of roughly two degrees), rainfall (by irregular amounts) (BIRCK *et al.*, 2005). The consequences of this variability are all the more emphasized in the marginal areas of the inhabited world, such as arid and sub-polar zones. As a result, the morphogenesis and the hydrological rhythms of rivers and thus the hydro-morphological hazards have evolved. For example, in its lower part, the hydrology of the Rhône River varied between calm periods such as the Medieval Warm Period, and other periods dominated by more exceptional occurrences, such as the Little Ice Age (ARNAUD-FASSETTA, 2000; 2008; 2009).

During the Holocene, the impact of non-cataclysmic natural hazards has greatly interplayed with anthropogenic forcing. The changes societies have brought to the exploitation of drainage basins have interacted with those natural processes, sometimes worsening environmental disasters, sometimes balancing them out (DIAMOND, 2006). This is how – due to erosion linked to the agricultural exploitation of its hinterlands and the progradation of the Küçük Menderes Delta –, the city of Ephesus (fig. 1) ended up ceasing to be a port (KRAFT

et al., 2007). However, cities do not merely suffer from their environment, they affect it themselves.

THE IMPACT OF CITIES ON THEIR ENVIRONMENT

From the very beginning of its life, a city has a considerable impact on its environment. Huge numbers of inhabitants, as in Xi'an (fig. 1) where there were already about 100,000 inhabitants in 1000 BC (MODELSKI, 2003), have always been conducive to epidemics (HAYS, 2005; LIANG *et al.*, 2018), pollution (BORSOS *et al.*, 2003), and a heightened consumption of energy and natural resources. The supposed plague that hit Athens (fig. 1) from 430 to 426 BC (HORNBLLOWER *et al.*, 2014), which was more probably a typhus epidemic, is still remembered today. Such paleopollution appears in geoarchaeology in the study of intra-site sediments (ZHANG *et al.*, 2005), or that of sedimentary archives in ancient port basins (MORHANGE *et al.*, 2015). Thus geoarchaeologists use levels of lead, scoria and heavy metals to trace and mark out the past, whilst the study of skeletons in necropolis offers a glimpse of the health of an ancient population and the impact of chronic illnesses and epidemics (WALDRON, 2009). The most finely developed ancient urban societies took measures against some of these risks, as far as the knowledge of their era allowed them to. One needs look no further than supplies of clean drinking water; fountains; urban water tanks; qanat networks (BRIANT, 2001) – which became commonplace across the Iranian plateau and beyond in the first millennium BC –, or Roman aqueducts (BONNIN, 1985); waste disposal and wastewater disposal; the establishment of cemeteries outside of the city; legislation aiming to curb the risk of fire; paraseismic construction practices; the building of dykes and levees; or the confinement of polluting activities or industries, for example tanneries situated in their own specific neighborhoods. We must be careful, however, not to apply modern standards of safety and responsibility to ancient urban societies.

THE NEW RESPONSIBILITY OF CONTEMPORARY URBAN SOCIETIES

In an epidemiological as well as an environmental sense, there is most definitely a difference in size between ancient and modern urban societies. Our civilization, with its knowledge of the tectonic plate theory and its vast progress in geosciences and biology, is the first to have gained a scientific understanding of the genesis of volcanic eruptions, earthquakes, tsunamis and landslides, as well as of the environmental disasters or health crises of the past, and the first to have conceived of forecasting such phenomena. Considering current scientific and technological expertise, preventing major and natural hazards should be a top priority for cities all over the world, based on a five-point plan: studying dangers, knowing what is at stake, defining risks, adopting urban planning regulations, and educating city-dwellers on the states of crisis specific to each urban context. Be it due to a lack of specialists, a lack of resources, an absence of political will, corruption, or misunderstood financial interests, such a plan is still a rare exception in the world today.

WHAT CAUSES A CITY TO DISAPPEAR?

Seeing as cities are each built on areas with their own topography, with site constraints and hazards linked to these dangers, they are social, economic, religious, and political products. By way of proof, all cities, throughout history, have been created either by a myth or by a decree. In the Middle East, the first cities to be recognized and partially explored were, obviously, new cities (MARGUERON, 2004), clearly built by political will. Later, foundations

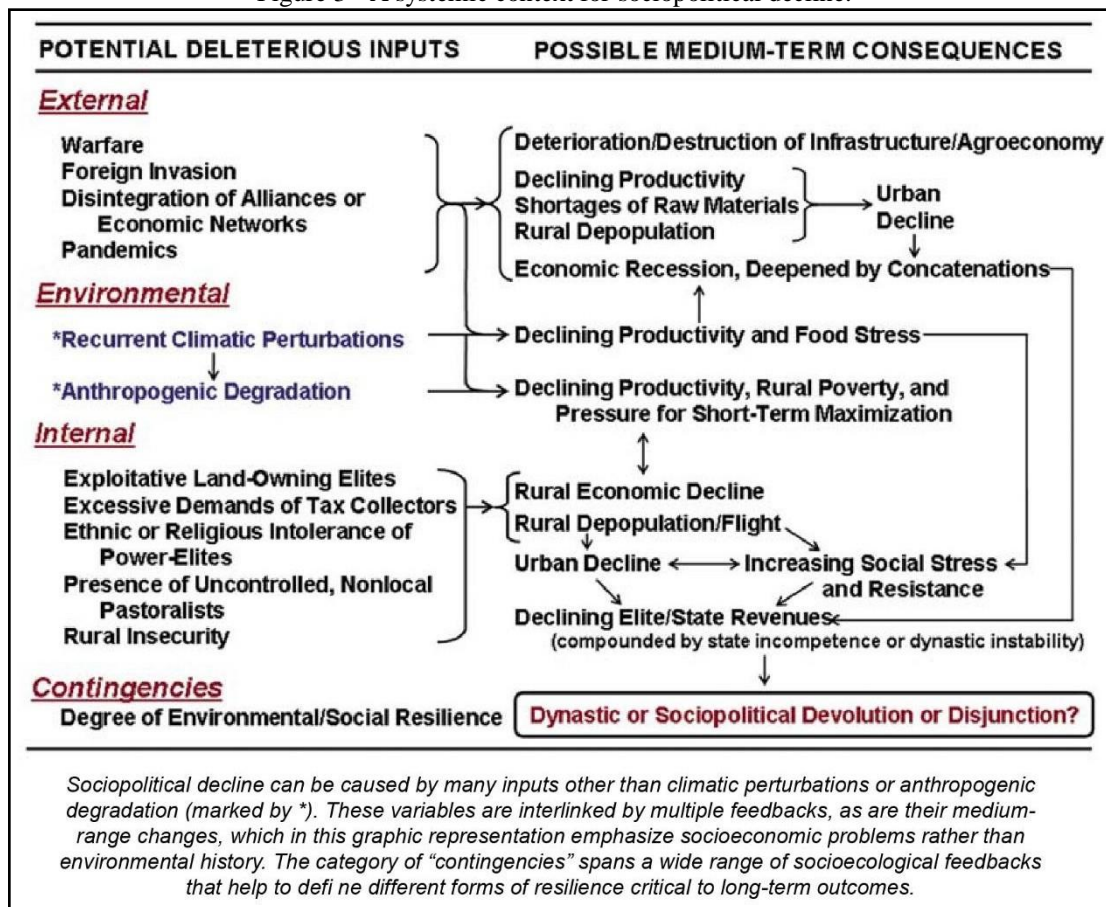
were in fact often found to be hiding refoundations, and the desire of authority to forever leave its mark on history. The city of Kar-Tukulti-Ninurta (EICKHOFF, 1985) is emblematic in this sense: situated on the right bank of the River Tigris (fig. 1), where modern-day Iraq stands, it was founded in such a way by King Tukulti Ninurta I, who ruled from 1244 to 1208 BC. This veritable new city boasted a design based on quadrilaterals, long orchard paths and baked-brick ramparts. The king wanted it to be a new capital, but he died before it was finished, and the city soon crumbled.

What archaeology teaches us is that cities disappear with the civilizations that founded them, for reasons often far more social, political, or religious than environmental (fig. 3). The aridification of the global climate (KUZUÇUOĞLU; MARRO, 2007; FOUACHE *et al.*, 2009) that followed the Holocene Climate Optimum is often put forward as the reason behind the great cultural crises that occurred in the Near East, such as the fall of the Akkad Empire (WEISS *et al.*, 1993) in the Arabo-Persian Gulf, or the abandonment of Harappan cities in the Indus Valley (DUTT *et al.*, 2019; fig. 1). This aridification was most probably caused either by thousand- or hundred-year fluctuations, by some sudden turn of events, or by a progressive evolution of the climate towards dryness, connected with the waning of the Indian monsoons (LÉZINE *et al.*, 2007; DUTT *et al.*, 2019). Pollen, speleothem and lacustrine deposit analyses in the region show that this waning of the Indian monsoons from 4700 to 4200 BP (IVORY; LÉZINE, 2009; DIXIT *et al.*, 2014; DUTT *et al.*, 2015), was very real, but an actual link with the collapse of late Bronze Age civilizations is debated (KNAPP; MANNING, 2016). The widespread collapse of Classic Maya polities occurred in a context of climate-driven environmental change between 600 and 1000 AD (KENNETT *et al.*, 2012). A series of major droughts triggered a decline in agricultural productivity and contributed to societal fragmentation and political collapse (KENNETT; BEACH, 2013).

When we discuss the collapse of Bronze Age civilizations in the Near and Middle East, we thus must take care to distinguish vast urban centers, economic, political and cultural hubs that are very dependent on external flows, and, as we have intimated, were very quickly abandoned at the end of the third millennium, and small urban and rural sites (ISSAR; ZOHAR, 2007) like those, for example, of the Sabzevar region (FOUACHE *et al.*, 2010) in Iran (fig. 1), which have been occupied consistently throughout their existence. One must also consider the duration of aridification, which is by no means a quick and brutal process, but rather a slow evolution over the course of 600 years. To attribute the collapse of those Bronze Age civilizations to the only climatic factor in question seems, in the light of current archaeological knowledge, a gross simplification (KNAPP; MANNING, 2016).

If we move to Central Asia, and protohistoric Central Asia, recent archaeo-environmental research (CATTANI, 2005; FRANCFORT, 2005; FRANCFORT, 2009; FRANCFORT; TREMBLAY, 2010; LUNEAU, 2010; LIU *et al.*, 2018) seems to be showing us that the pinnacle of Oxus civilization came at the end of this phase of aridification, proven by environmental studies (CREMASCHI, 1998; LUNEAU, 2019), notably the advance of the Kara-Kum dunes (fig. 1) and the parallel southerly advance of steppe peoples (CATTANI, 2005); its collapse, meanwhile, most likely came with the beginning of a new humid phase.

Figure 3 - A systemic context for sociopolitical decline.



Source: Butzer (2011).

FINAL CONSIDERATIONS

We are fortunate to be able to use conservation-oriented archaeological digs to carry out, within a dense urban tissue, geo-archaeological studies of environmental processes. This affords us a better understanding of initial site constraints and allows us to piece together the dynamic evolution of environmental constraints which interacted with processes begotten by human development. This piecing together in turn affords us a better understanding of the perennial or random nature of hazards, lets us know when they will recur, and allows us to form more effective prevention policies. This environmental history can also form part of a city's heritage, a part that can be exhibited for all to see and- by placing a city's current situation in a dual history, that of the environment and that of human societies-, can be used for educational purposes in explaining the nature of hazards and the evolution of issues and risks. We must not, however, focus exclusively on environmental risks to our cities. Preventing major hazards, reducing pollutants and managing waste, optimizing the management of water resources, and harnessing the growth of megalopolis are all major issues; but- due to the huge numbers of inhabitants and their increasing concentration-, the greatest dangers to the long lives of our cities are actually, now as they always have been, social and political.

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