The Commodification of Water

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Water and the Neolithic Ethos[1]

Two basic behavioral dispositions in human water consumption should be distinguished: passive ones that could show a variety of adaptive behavior to forage or routinely access available surface water for immediate consumption, and more active and preventive dispositions that are in addition governed by the need to secure and manage water for drinking and its use in productive milieus. The latter represents the new sectors of complex human water management that increasingly spread with sedentary life and its socioeconomies, based on the need for stable conditions for their territories, climate and hydrology, agriculture, flocks, crafts, and social systems. More than ever before, water in the Neolithic became an agent of vulnerability. Both dispositions might already appear linked to some extent in hunter-gatherer groups (for example, in areas or cases of potential water pollution or in deficit locations), but basically the character of water behavior in these groups remained adaptive and exploitative. The two dispositions cannot be seen as opposed behavioral patterns; they remained linked in Neolithic times, with the productive water behavior involving increasingly complex risk-buffering strategies throughout the millennia of the Neolithic evolution. Sedentary conditions require such active water strategies, or water management, since even a secure natural consumption based on rich nearby springs would require a „hydrosocial" management to avoid deficits created by other impacts, such as territorial or ideological claims, hygiene, etc. The new Neolithic human territoriality must have created a new vital and potentially conflict-loaded level of dependence on water (Gebel n.d., 2010b), and human hydrological competence must have gained momentum in nature-observation, water technologies, and sociohydrological strategies.

Among other topics, much research needs to be invested into the ethological questions related water subsistence in early Near Eastern villages, since they would allow working out the assumed fundamental changes in water behavior coming up with the Neolithic. For example, to what extent was the choice of a spring location for an early village part of an active disposition or that shared much of the foraging attitude (*e.g.* the Ba'ja case, Gebel 2004b)? Or, what are the parameters by which simple water tapping from wadi gravels could be understood as Neolithic „water work"?

Water and Productive Milieus

Water, like mineral resources, forests, grazing land etc., was available in the sites' environments and was used by the productive milieus of the new Neolithic life modes. Often construction work had to be invested to harvest, manage and process water in these permanent acquisition, use and discharge frameworks: This notion of Neolithic water, still neglecting the changed cognitive disposition of man to water and the vital role it played to sustain sedentary territoriality, only started to change after 2000 when domestic water findings forced questions about the domestication of water (Peltenburg *et al.* 2000, 2001a-b; Gebel 2004b; Garfinkel *et al.* 2006; Gillmore *et al.* 2007a-b; Fujii 2006, 2007, 2010-this issue). Since the 1190's Neolithic research had become more open to the idea that "domestication" is not only a signal of biological mutation, but also of cultural mutation, of - partly fundamental - behavioral changes in symbolism, technological strategies, resource and space management, etc. Such sights had opened ways to new approaches and understanding of Neolithic abiotic resources, including water.

More than any other basic element or substance, water and the ability to manage its productivity were crucial for the establishment and preservation of permanent productive life modes. Beyond "foraging" water, settled life had to make water subject to permanent preventive care, as in cases of territorial, seasonal, hygienic, climatic impacts, among others. As the major agent securing the success of Neolithic production and storage modes in the emerging cultural landscapes of the Near East (*e.g.* Watkins 2009), domestic water studies deserve to become integral parts of Neolithic research projects without which evaluations of Neolithic socioeconomic strategies fail to be comprehensive and conclusive.

I propose to consider all human behavior and measures to secure water and water access and discharge beyond its immediate consumption as Neolithic water subsistence; this definition includes the features of permanent "water territoriality" as well as measures of water storage and safeguarding against water. In other words, Neolithic water subsistence is characterized by an active behavior to secure and optimize the biotic and abiotic conditions by which food and other water-dependent products become available. It means that productive milieus were maintained and ruled by artificial water conditions, and artificial water conditions determine productive milieus. Developing water techniques found their immediate reaction and expression in the communities' social, technical, environmental and symbolic evolution. Water storage of its various kinds and water-based land use are the key socio-economic sectors in which new water techniques influenced, triggered and protected new modes and structures of sedentary life. The specific regional or local blend of water conditions and related

technological opportunities created the special regional and local modes of water management. It is especially the storage aspect - from the possible harvesting of water in the sediments caught by wadi barriers to the introduction of impermeable containers - that makes water a subject of domestication, or commodification (Gebel 2010a), if not to speak of the „Neolithization of water".

Water was a basic commodity of Neolithic life. It was part of the early village reciprocity that was generated and supported by the commodification processes (*cf.* below) of its productive milieus, and played its vital role in many interacting contexts (landscape types, settlement patterns, resources, goods and labor, internal settlement/house organization, social identities, technological and ideological innovation); the need for, and use of, corporate and pacifying behavior and strategies to use water must have characterized the emerging Neolithic water frameworks. The Neolithic productive milieus are also known for their tendency for prolific momenta and accelerated developments, including the implosion of such processes (*e.g.* the Mega-Site Phenomenon, Gebel 2004a, 2007). Progressive population dynamics and surplus production appear to be related to new strategies of water management (*e.g.*, the development of hydraulic and pastoral societies in the 7th millennium BC): Water and its management in Neolithic times appears to have been a motor of innovation, and water deficits appear to have set free the strongest innovative energy. We have to expect that not only did water consumption increase due to the increasing population sizes, but also that the individual water consumption increased by the various new and prolific production spheres, probably introducing "modern" problems like the depletion of water resources and their quality or the reduction of biodiversity.

Basic work has been carried out on protohistoric and historic productive water milieus (*e.g.*, Wilkinson 2003, Brunner n.d., and others), and studies such as that by Araus *et al*. (1999) remain scarce in Neolithic research. Rather, prehistorians "meet" findings of Neolithic water work and so far interprete them in their conventional frameworks. However, and as a start, several models developed for later periods could be transferred with some modification to the Neolithic (such as the "water cube" of Ueli Brunner, Fig. 1).

Among others, the key questions of T.J. Wilkinson (2010- this issue) are vital for research success in Neolithic water management. Especially obstacles and limits have to be taken into account, such as the preservation of Neolithic water installations in the landscape (their ephemeral or non-permanent character, the re-use of such structures in succeeding periods, *etc*.). The Ma'an evidence (Fujii 2010- this issue), for instance, has probably survived because it came to exist in a marginal location that was not later re-useable as an irrigable wadi system. Apart from standard methods (sedimentology/granometry, ^{14}C/TL/OSL dating, ICP-MS, palaeoethnobotany/palaeopalynology, traditional survey and excavation) much pioneer research would be needed to evaluate chances for data from indirect evidence of water use.

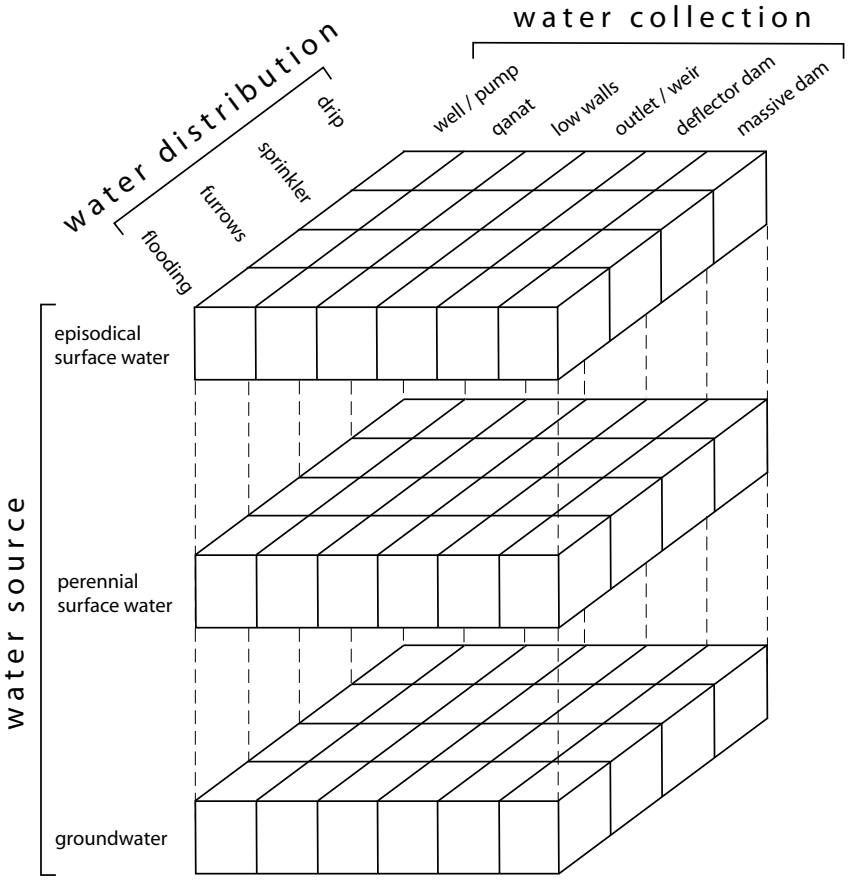

Fig. 1 The "water cube" of Ueli Brunner, developed for the antiquity (Brunner n.d., reproduced with the kind permission of the author).

Water and Commodification

This contribution to the special topic issue of Neo-Lithics on The Domestication of Water (Neo-Lithics 2/10) aims to adumbrate a new interpretative framework for Neolithic water, leading beyond the limits of its segregated understanding as an individual ingredient of Neolithization (or as an isolated "cultural domesticate"), offering rather its holistic contexts by understanding water as part of the Neolithic commodification processes (*cf*. Table 1).[2, 3]

The domestication of water might be understood as any sort of a constant human manipulation

Environmental, Socio-Economic, and Cognitive Subsystems of Water Commodification	**Water Sources/ Aquatic Habitats**	**Acquisition Level** **(A) Procurement and Control Management**	**Consumption Level:** **(B) Production and Refinement**	**Consumption Level:** **(C) Processing / Use**
Local Environmental Subsystem: (1) Local Sources and Conditions	specific local environmental conditions of water availability (topography, precipitation/ melt water/ climate, sub-surface drainage, water storage capacity of soils/ woodlands/ etc., vegetation cover, etc.) permanent, intermittend, seasonal and/ or ephemeral water sources/ aquatic habitats: surface water: seepages, pools, springs, lakes, rivers, marshes/ swamps, brackish waters/ *sebkhas*, sea aquifers/ groundwater rain-fed drainage systems (potentially) arable rain-fed/ irrigable land, grazing land, drainage systems stability/ instability of water sources and related habitats water-salt balance parameters	removing water from open and "opened" (e.g. tapping aquifers, alluvial fans etc.) sources for consumption, craft work, gardening etc. ?manipulating groundwater (streams?) run-off/ flood water management relocating water from source for watering/ irrigation local exploitation of fresh- and seawater habitats: (seasonal) fishing, shell-fishing, amphibians, fowling, hunting, shell collection for ornament industry/ trade local share of (potentially) arable rain-fed/ irrigable land, grazing land, drainage systems etc. in relation to non-productive habitats	establishing hydraulic landscapes/ landscapes with water installations: building and maintaining irrigations systems gardening and farming, animal husbandry sedimentation/ salinization/ water logging impact management	direct consumption of water at natural source (humans, animals)
Regional Environmental Subsystem: (2) Regional Sources and Conditions	specific regional environmental conditions of water availability (topography, precipitation/ melt water/ climate, water storage capacity of soils/ woodlands/ etc., vegetation cover, etc.) permanent, intermittend, seasonal and/ or ephemeral water sources/ aquatic habitats: surface water: lakes, rivers, marshes/swamps, brackish waters/ *sebkhas*, sea aquifers/ groundwater (potentially) arable rain-fed/ irrigable land, grazing land, drainage systems stability/ instability of water sources and related habitats	removing water from source for consumption, for craft work etc. run-off/ flood water management relocating water from source for watering/ irrigation regional exploitation of fresh- and seawater habitats: (seasonal) fishing, shell-fishing, amphibians, fowling, hunting, shell collection for ornament industry	establishing hydraulic landscapes/ landscapes with water installations: building and maintaining irrigation systems	direct consumption of water at natural source (humans, animals)
Exchange/ Network Subsystem: (3) Long-Distance Sources	long-distance influence/ impacts on water availability (precipitation/ melt water/ climate, topographies, vegetation zones, etc.) permanent, intermittend, seasonal and/ or ephemeral water sources/ aquatic habitats: surface water: rivers, sea aquifers/ groundwater streams (potentially) arable rain-fed/ irrigable land, grazing land, drainage systems stability/ instability of water sources and related habitats	long-distance exploitation of fresh- and seawater habitats: (seasonal) fishing, shell-fishing, amphibians, fowling, hunting, shell collection for ornament industry		sea-based network transport/ migration/ trade, seafaring river-based network of transport/ migration/ trade
Technological Subsystem: (4) Household Production		clean/ potable water procurement and hygiene measures ? tapping aquifers/ groundwater by digging wells rainwater harvesting	intra-mural structural measures to protect houses from rain, moisture and surface water/ for habitational comfort water-based health/ sanitation management building and maintaining horticultural, field and irrigation systems, animal husbandry production of organic and mineral containers for water transport and storage water-using household activities (food processing, tanning, tool production, etc.) house supplies of water field and gardening techniques (e.g. soil moisture enhancement, land use intensification by watering etc.)	water-based health/ sanitation management/ potable water treatment wastewater management fire fighting water

Technological Subsystem: (5) Specialized Work		?impact management (water logging, salinization, sedimentation etc.) tapping aquifers/ groundwater by digging wells water collecting/ hauling techniques and equipment	?construction/ maintainance supervision in water works ?well builders and maintaining ?boat builders "industrial" water in crafts (e.g. pottery, tanning, ground stone industries) irrigation in rain-fed agriculture	?construction/ maintainance supervision in water works ?impact management (water logging, salinization etc.) ?well builders and maintaining ?water guarding sea-/ river-based trade
Technological Subsystem: (6) Corporate/ Community Enterprises		corporate/ communual water supplies, tapping of aquifers/ groundwater by digging wells intra-site and intra-mural structural measures to protect houses, corporate space, fields, springs etc. from rain and surface water ?impact management (water logging, salinization etc.) measures against cataclysmic water events (floods, land slides etc.): deflection walls, dikes and ditches (protecting landscape topography, fields, site fringes, houses) rainwater harvesting	built structures of corporate/ communual water (springs, wells, channels etc.) intra-site and intra-mural structural measures to protect domestic areas, corporate space, fields, springs etc. from rain, moisture and surface water storage of water by cistern-type of constructions or natural traps water-based health management relocating water to fields and gardens, maintenance: contour ditch irrigation/ contour check method, basin irrigation, submersion irrigation, ?free flooding, storage of moisture by soil retaining walls	?water-guarding water-based health/ sanitation management/ potable water treatment wastewater management fire fighting water sea-/river-based trade
Socio-Economic Subsystem: (7) Social Means	territorial control of water sources economic organization and rights of water access and procurement at regional and distant water sources for mobile herdsman engaged also in hunting/ gathering/ fishering, or for foraging groups still in the area regional and distant water sources as places of social contact and exchange	social organization and status questions of labour in water working, ?water management hierarchies, conveyance regimes local/ regional coordination of water working corporate standards/ behaviour and (socio-political) organization of: clean/ potable water procurement and hygiene measures, water distribution/ irrigation/ deficit management, intra-site measures to protect houses and corporate space etc. from moisture, rain and surface water, measures against cataclysmic water events (floods, land slides etc.) water and gender	social organization and status questions of labour in water working, ?water management hierarchies, conveyance regimes local/ regional coordination of water working corporate standards/ behaviour and (socio-political) organization of: clean/ potable water procurement and hygiene measures, water distribution/ irrigation/ deficit management, intra-site measures to protect houses and corporate space etc. from moisture, rain and surface water, measures against cataclysmic water events (floods, land slides etc.) water and gender	conveyance regulations sea-/ river-based exchange and migration
Socio-Economic Subsystem: (8) Economic Means	economic importance of water access and procurement at regional and long-distance water sources for mobile herdsman engaged also in hunting/ gathering/ fishering, or for foraging groups still in the area	economic organization of labour in water working local/ regional coordination of water working economic organization of water access and procurement including irrigation and deficit management rainwater harvesting	surplus production through water, and its reliability ?water supplies function as stored nutrition and productive means storage of water in organic and mineral containers, cistern-type constructions, natural traps storage of moisture by soil retaining walls (fields)	surplus production through water, and its reliability sea-/ river-based exchange and trade
Cognitive Subsystem: (9) Innovation	regional and distant water sources as places of exchange	social, economic and cognitive innovation related to water procurement and management ?sustainable integrated water resources management sustainability of water management (efficiency, conservation/ recycling etc.)	social, economic and cognitive innovation related to water-related production and refinement	social, economic and cognitive innovation related to water processing and use sea-/ river-based exchange of innovation
Cognitive Subsystem: (10) Tradition/ Conception/ Ritual	water territoriality, ?territorial water identities ?perception of water/ water-modified landscape regional and distant water sources as places of social contact and ideological exchange	the local water commodication (regime) and its ideology in general ?planning in water consumption, land use cropping arrangement water territoriality, ?territorial water identities water-related conflicts and conflict management corporate/ communual and individual rights in water access and procurement culturally induced measures, values and elements of water procurement and control for ritual, hygiene, of property etc. water and gender	the local water commodication (regime) and its ideology in general ?water supplies understood as stored nutrition/ liquid food and base of wealth culturally induced measures, values and elements of water procurement and control for ritual, hygiene, of property etc. "holy water" water and gender	the local water commodication (regime) and its ideology in general sea-/ river-based exchange of ideas, values, symbols, innovation etc. culturally induced measures, values and elements of water procurement and control for ritual, hygiene, of property etc. "holy water" water and gender

Table 1 Preliminary attempt by author to structure potential features, parameters and questions of the early water commodification regimes in the Near East in subsystems and context/ use levels. (for this system's approach *cf*. Hermansen and Gebel 2004)

of water and water resources in productive systems; the commodification of water understands water in the same way, but in addition traces its value and value-producing importance and consequences in the cognitive, social, economic, and technological contexts of a Neolithic society: Neolithic people granted values to water (as an object of commodification), and water gave values to people and their social relations. Here it is advocated that the emerging and accelerating human control of biotic, abiotic, and non-material resources under sedentary conditions during the Near East's 11th to 6th millennia BC should be seen as parts of an overall Neolithic commodification process; Neolithic manipulation and control of resources has comprehensively affected all material and mental environments of emerging domestic life, including steering its technological progress, social developments, and ideological spheres. Potentially, most resources were subject to processes of commodification, and Neolithic water was no exception.

Whenever direct consumption of resources – including water – becomes dependent upon stocks (foraging to food producing), it becomes necessary to protect these supplies and to structure their allocation; water was the essential element to sustain these. At the beginning these supplies were probably predominantly nutritional, and included the developing idea that the food-producing land around the group's settlement including its water is supply in the shape of property. But the organization of supplies, and the activities necessitated by the need to accumulate supplies, forced people to commodify or give value to things – including water – and then further to secure these values by supporting them with ideologies. However, we do not wish to make the mistake of restricting incipient commodification to artificial or natural supplies. Commodification, or the attribution of value to things, may, but need not, originate from sustaining supply systems.

What were the Neolithic milieus in which water became a material and non-material commodity? Progressive population dynamics through philopatry, the wealth of time and goods beyond subsistence needs, and competition through diversification gave order to life and generated social identity. Commodification promoted security on all levels, as de- and ex-commodification could do: The internal and external security of the individual, his/her group, and his/her koinon (*sensu* Jacques Cauvin) is balanced by commodification regimes. The values commodification provides – including those of commodified water – are essential to maintain sedentary loyalties and structures: productive types of commodification are directly related to a sedentary ethos and territoriality, and would hardly work in non-sedentary societies (Gebel 2010a, n.d.). The commodification of water also meant dependence on and inflexibility through all sorts of water-based specialization in the early productive milieus, triggering interrelated exclusive behaviour and acceleration/agglomeration processes.

As far as the definitions of commodities and commodification are concerned I refer to (Gebel 2010a) wherein the original ideas and definitions of Appadurai (1986) and Kopytoff (1986) had been modified and „translated" to the Near Eastern Neolithic conditions. According to these definitions, Neolithic water could have - in addition to its basic importance as drinking water - the following major characteristics (preliminary):

1) It is subject to consumption and territorial claim.
2) Its availablity assists the survival of social, economic, political, and ideological systems. It can be used to produce prestige, commemoration, and values.
3) It is endowed with social power, including symbolic power (e.g. identity through joint water ownership).
4) It causes and initiates services and ideas helping to establish belief systems, innovations, social standards, etc.
5) It is defined by certain social and ideological settings or arenas which prompt the character, alteration, and even disappearance of its commodity state.
6) It helps to produce material values for daily life and material exchange /surplus.
7) It creates other commodities or initiates commodification chains. For example, domestic (and ritual?) water can simultaneously be a commodity and commoditize space and things.

Following the understanding of water as a commodity in sedentary Neolithic systems, Table 1 represents a preliminary exercise to structure parameters and features of Neolithic water in subsystems and use/context levels.

Domestic Water and Its Early Evidence

After the very early evidence for wells (Early PPNB; Peltenburg *et al.* 2000, 2001a-b) in the littoral sedimentary rocks of southwest Cyprus became known, followed by reports on earliest PPNB basin irrigation using dams near Ma'an (PPNB; Fujii 2006, 2007, 2010- this issue), the hydrological background of Neolithization became an imperative topic in Neolithic research. From the evidence we have it cannot really be stated when, how, and where water started to be a commodity (in the sense above); probably such questions are irrelevant. Control strategies in water acquisition and procurement by modifying landscapes through dams or locating settlements in certain favourite hydrological settings to allow well digging evidently appear with the beginning of sedentary life's productive milieus. The evidence assembled in this issue of Neo-Lithics suggests that after the long

history of direct water consumption at sources, early Near Eastern water commodification went through the following steps[4], characterized by their most progressive feature. I am aware that this simplistic trajectory is misleading for the actual and innovative regional trajectories which led water technologies to migrate to regions with similar conditions, but for the sake of clearity I dare to simplify the potential overall development:

1) Removing water from natural sources for consumption, and early long-distance use of rivers or the sea to spread productive milieus.
2) Removing water from manipulated or constructed sources for consumption, while establishing permanent life near water sources.
3) Territorializing water by permanent networks and/or transport means.
4) Relocating water by networks.

With respect to sedentism and water, it is necessary to mention that a stable and permanent occupation of the Arabian Peninsula only became possible by the latest act in Near Eastern water commodification during the formation of the Early Bronze Age oasis agroeconomy in the 4th millennium BC. While the western Near Eastern sedentism trajectory was fully established only by the various irrigation techniques in its riverine and alluvial lands of the 6th millennium, the arid lands of Arabia apparently "needed" an adaptation from the pastoral well cultures of the 5th millennium (representing periods of more moisture) into the oasis channel/ shadow horticulture or agroecosystem of the 4th millennium, following the onset of drier and cooler climate (Gebel and Mahasneh n.d.). This in a way also emphasizes that the Near Eastern establishment of sedentism was a matter of environmental technology and adaptation rather than a restricted Neolithic feature. Wells from present-day arid Chalcolithic landscapes are reported from the 'Uvda Valley (Avner 2002), Rajajil near al-Jawf/Skaka (Zarins 1979), and Qulban Beni Murra (Gebel and Mahasneh n.d.).

While foragers' camp sites apparently were related to springs and water courses, their locations seem to have respected the wild games' access to water and other factors related to water (such as insects). This adaptive attitude to water locations had to be given up whenever sorts of permanent life was established near water sources. The hitherto oldest primary evidence of water commodification, surprisingly, does not come from the Near Eastern mainland, but from the EPPNB of Cyprus („Cypro-PPNB"). In Kissonerga-Mylouthkia (*ca*. 8500 and *ca*. 7000 cal. BC; Peltenburg *et al.* 2001, pers. comm.) in littoral southwest Cyprus, several water wells with foot holes were found dug into the local havara (a kind of stiff marl) bedrock to tap underground watercourses. Their depths vary between 6 and 12 meters. Each well has a chamber-like extension at the bottom of the cylindrical shaft, cut into the impermeable limestone below the watercourse. When abandoned, the wells were deliberately filled with cultural debris and organic matter, helping to date the (undisturbed) fills to the later 8th millennium BC. Contemporary wells have been found at other Cypriot sites, such as Parekklisha-Shillourokambos. I think, E. Peltenburg (Peltenburg *et al.* 2001a: 47) is perfectly right in assuming that „well digging expanded with the growth of sedentism" rather than being forced by a PPN increase of settlement sizes. However, it should be questioned if well-digging really is a „western hydrological development": the still missing early evidence in the non-littoral PPN core areas of the Levant could have much to do with the mountainous or terrace settings of sites. Here underground watercourses probably were tapped mostly outside the immediate domestic areas by water holes and wells. Not much technological cognition is needed to "arrive" at a shaft well from the simple water hole experience: only the labor investment and its organization, both in building and maintaining a well, might require a different level of social networks.

The introduction and establishment of farming during the 9th and 8th millennia BC not only countered climatic variability as a potential threat to a stable subsistence economy, it also created new dependencies and balance regimes on/with water. Site settings were chosen to meet with several environmental needs, not only water, including the distance to fields, mineral resources (building material), etc. Natural landscapes were transformed into cultural landscapes and became productive territories, resulting in demographic growth and the spread and aggregation of settled people. Pressure must have reached "fringes" such as the Ma'an area that certainly witnessed a moister climate in the PPNB. The setting and palaeohydrological situation of the Late Pre-Pottery Neolithic B site of Ba'ja north of Wadi Musa provided strong secondary evidence for water harvesting by dams, or (at least) of a village sustained exclusively on tapping aquifers (Gebel 2004b). It is argued that the gorge's special topography forced the torrential run-off water to seep into its aquifers, which must have been one of the reasons for the choice of this extreme intra-montane location in an environment otherwise devoid of perennially flowing surface water.

Apart from the Early Neolithic well evidence of Cyprus, Shar Hagolan (Garfinkel *et al.* 2006) and Atlit-Yam off the Carmel Coast (Galili and Nir 1993; Galili and Sharvit 1998) provided prominent and clear primary evidence for PPNC well shafts. Atlit is a submerged site of some 4 ha at 8-12 m b.s.l.; its wells must have been subject to the previous coastal plain groundwater table that was affected by sea-level changes. More Pottery Neolithic wells existed in the neighboring submerged sites of Kfar Samir, Kfar Gilam, Tel Hreiz, Megadim, and Neve-Yam. Two wells have also been reported from Hacilar VI (Mellaart 1970).

The Pottery Neolithic witnessed the widespread establishment of impermeable vessels, advantageous for any sort of hygienic storage including water

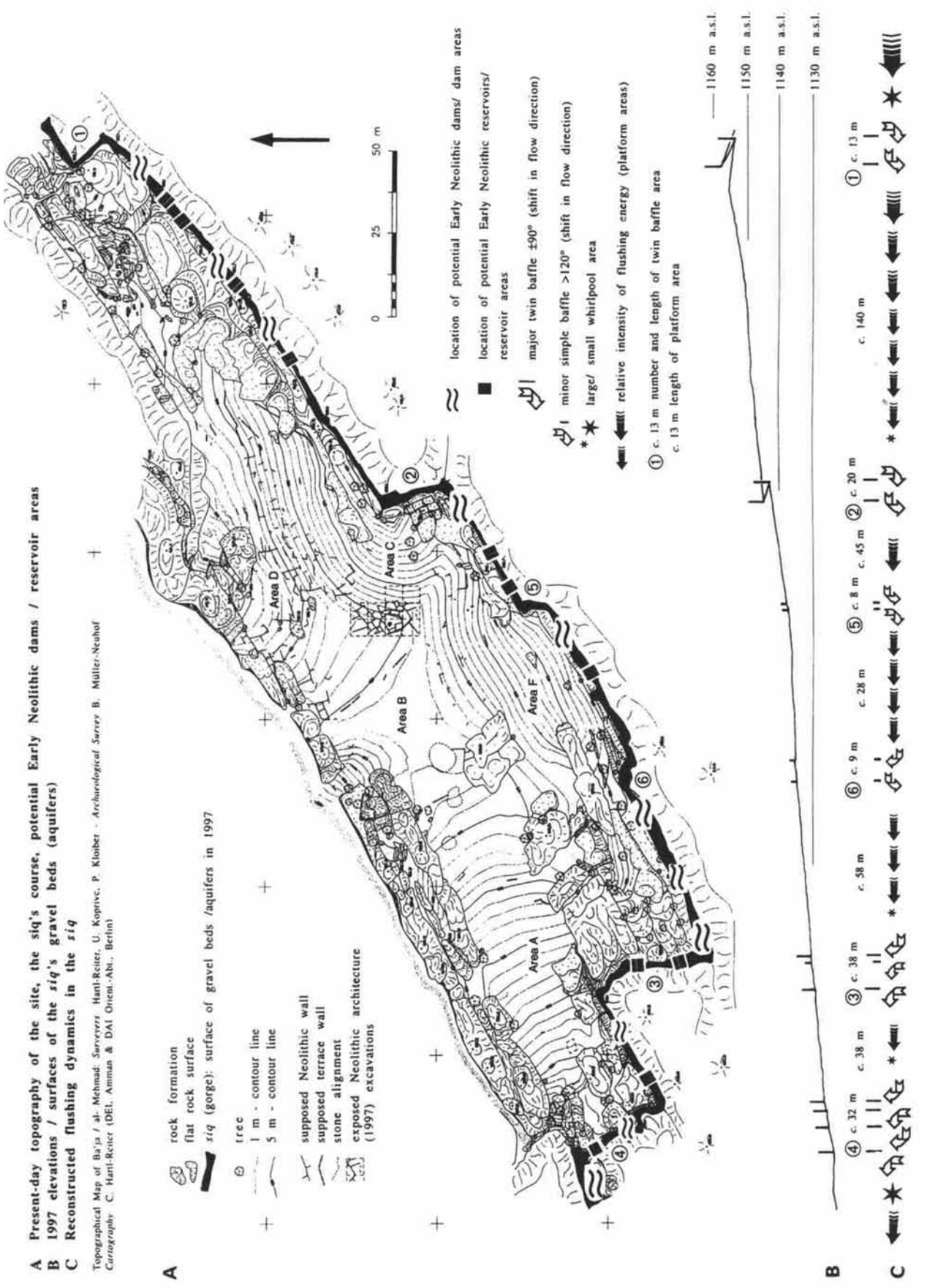

Fig. 2 Reconstruction of LPPNB Ba'ja's palaeohydrological setting and potential water harvesting. (from Gebel 2004b)

brought from some distance. Very little primary evidence, together with secondary evidence based on various palaeoecological arguments, can be cited for another epoch-making water technology in the Near Eastern Pottery Neolithic and the immediate post-Neolithic. The valleys of the Tigris and Euphrates drainage were the regions that introduced and established the first irrigation techniques. The advent of irrigation remains poorly known, and certainly it regionally prevented, delayed, or made impossible an efficient drainage that would avoid waterlogging and salinization. While irrigation generally is expected for the 6th millennium BC, Araus *et al*. (1999) would not exclude primitive irrigation at PPNA Tell Halula. I expect that contour ditch irrigation is likely to have been in practice from the Umm Dambaghiyah/ Ubaid 0 periods (6900 BC onwards), if not earlier in certain locations. It must have been a minor step in the human experience to understand that flooding slope areas helps to control flooding of fields on the valley floor. Submersion irrigation and arboreal shade in this topography would have allowed other types of crops to be raised. However, it could have developed in just the opposite way: that slope irrigation developed from irrigated basins in the valley floor. The alluvial (hydraulic) Hassuna, Samarra-Halaf and early Ubaid expansions (6400-5800 BC) most likely were based on developments in submersion irrigation using small basins as fields; at the Samarran site of Choga Mami a large irrigation canal was found. Permanent farm life entered the steppe fringes of the Mesopotamian rivers and faced local salinization problems due to absent or restricted drainage layers. In the lowland of the Deh Luran, western Iran, substantial evidence for agriculture and population growth is attested as the Pottery Neolithic approached, simultaneously witnessing the introduction of irrigation agriculture (Hole 1977, Neeley and Wright 1994). At Tell Pardis (in the Tehran Plain, *ca*. 5000 BC) a small channel-like feature was exposed in a section of a brick quarry, running at right angles to several other natural channels in the sequence, suggesting the management of water resources (Coningham *et al*. 2006; Fazeli et al. 2007; Gillmore *et a*l. 2007a-b). The Jeitun Sites at the edge of the Karakum Desert, Turkmenistan, possibly also witnessed early irrigation, benefiting from a high water table, swamps, and seasonally flooded surfaces (Harris *et al*. 1993; Harris, Charles and Gosden 1996; Kohl 1981).

As noted above, the Pottery Neolithic with its hydraulic innovations must be seen as the confirmation of the Neolithic trajectory for the alluvial lands of the Near East, while the development of pastoralism and transhumance ratified the success of the Neolithic trajectory in its mountainous zones and semi-arid fringes. In the Fertile Crescent's post-Neolithic periods, the development of the later literate civilizations, the early state societies, appears to be fueled in most respects by their sociohydrologcial coordination, progress, and regression.

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Endnotes

[1] For the term "Neolithic ethos", *cf.* Gebel 2010a.

[2] The author's long research on the Near Eastern Neolithic has resulted in the realization that the formation of Neolithic life and social identities was governed by interfering commodification regimes that were conditioned by the specific blend of productive milieus and their specific complexities that the specific conditions in the diversified Near Eastern regions allowed (Gebel 2010a).

[3] For German speaking colleagues I should explain that the term Kommodifizierung is used here in its special Neolithic sense, meaning Wertschaffungsprozesse, Wertschöpfungsprozesse or Inwertsetzungsprozesse at the advent of producing economies; Werte- und Wertbildungsprozesse would come closer to the meaning discussed in this contribution.

[4] These are preliminary, as the evidence presented in this chapter is selective.

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