

The Hevsel Gardens: archives of human activities and of the past and present evolution of the River Tigris at Diyarbakır

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EDITOR'S NOTE

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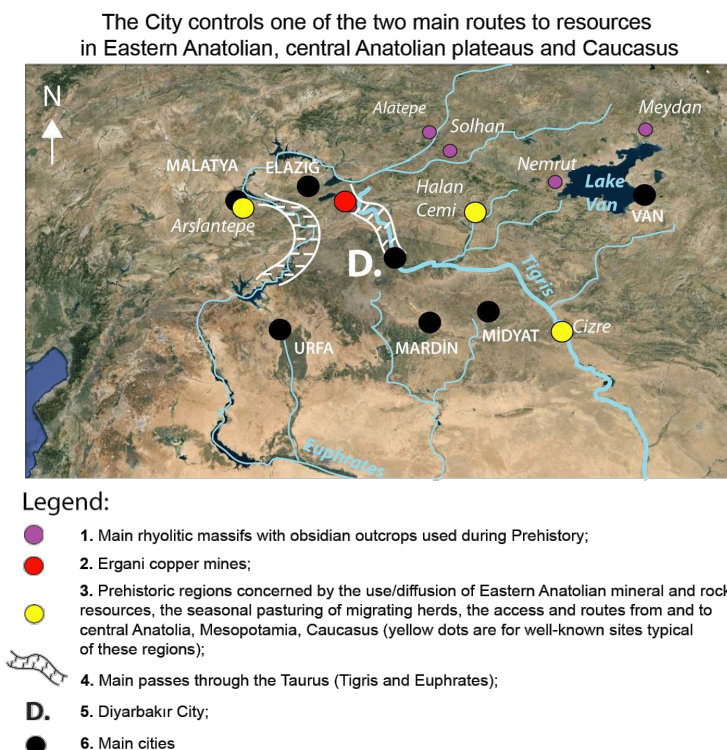
Introduction: context of research

- 1 The Tigris valley is a special area that requires examination from both archaeological and geomorphologic perspectives (Algaze *et al.* 1991; Parker and Creekmore 2002; Karadoğan and Kozbe 2013; Kuzucuoğlu 2014). In spite of this high interest, the knowledge of the geographical context of the region in the past is still restricted. As lakes and valley floors contain the best archives that would reduce this international information gap, we have set up a research project on the Upper Tigris watershed. Draining a large part of Upper Mesopotamia up to the eastern Anatolian highlands, this watershed must contain indeed the morphological and sedimentary data capable of defining (i) today's dynamics of the hydrosystem and fluvial ecosystem on a regional (e.g. the river watershed) and local (e.g. Diyarbakır City and Hevsel gardens) scales, whether controlled by man or by natural context (geology, climate, vegetation), (ii) the evolution of the climatic and environmental contexts in the region during the last glacial (Upper Pleistocene) and today's interglacial period (the Holocene), and consequently (iii) the geographical context of human societies' evolution in the River Tigris valley from the earliest Prehistory to the modern times (Fig. 1).
- 2 In this frame, the study of fluvial archives aims at understanding river dynamics today and in the more or less recent past, focusing namely on the river regime (timing, magnitude, regularity of floods, and relations to climate), the sedimentation modes and sediment types, the changes in bed types and location, the bank-bed-valley floor erosion, the terrace records, the substratum constraints etc.

I. Scope and approach

- 3 A series of general questions conducts our approach and methods.
 - What kind of events, what kind of records, framed in which chronology can we expect from the study of (i) the stepped terraces which are clearly recognizable in the landscape on both sides of the river valley and (ii) the various sediment fills and river morphology changes also recognizable in the valley bottom?
- 4 The study of these terraces and valley fills is expected to allow evidencing different phases of sedimentation and erosion, and identifying the causes and processes of changes in dynamics, (Kuzucuoğlu *et al.* 2004). In this prospect, we expect from a focus on the connections between the terraced Hevsel gardens and today's environmental dynamics, to provide results contributing to the reconstruction and understanding of the river imprints over the geographical formations in the valley through time.

Figure 1 - Diyarbakır, at the entrance of the Tigris gorge before crossing the Taurus range



Background image: 2015 LANDSAT TM satellite image distributed by Google Earth

- What kind of relationships was established in the past between human societies, the river dynamics (floods, low waters, erosion, lateral translation, incision, navigability etc.), its valley and terraces (topography and resources such as soil and vegetation, humanized landscape such as roads, walls, dams, canals, mills...)?

- 5 Answering this question requires the detailed reconstruction of both the palaeoclimatic and the palaeohydrological contexts of the region. This objective can be reached with the study of various indicators contained in the geomorphologic and sedimentary archives, whether their nature is stratigraphic, biologic, chemical, mineralogic etc. Such archives exist in the valley bottom and slopes, and in closed depressions especially those that have been occupied by a lake (Kuzucuoğlu *et al.* 2011).

II. Methods

- 6 After an exploratory field survey was realized in February 2014, the mission that took place in May 2014 focused on the zone of interest for the AMIDA project: the Hevsel gardens at the foot of the Diyarbakır City walls.

Figure 2 - The terraces of the River Tigris at Diyarbakır on the right bank below the City Walls



Photographed from the left bank

- 7 A second area also attracted our attention and efforts because of its richness in lakes: the river valley between Bismil and Batman. The results obtained in that latter area being out of scope of this paper on the Hevsel gardens and Diyarbakır area, they are not presented here.

Figure 3 - An open section in terrace sediments inside the Hevsel Gardens



- 8 Methods applied in 2014 for the study of the Hevsel gardens are:

On the field

1. Looking for open sections (Fig. 3), and drawing them;
 2. Identifying former beds and distinguishing possible terraces using (a) apparent water and clay content of sediments; (b) soil types, (c) land use and vegetation type (cultivated trees, planted vegetable gardens, crops) as they are also adapted to characteristics of soils and water content;
 3. GPS data are measured at more or less regular intervals along a transect-line established through the valley from the right bank of the river active bed, to the foot of the city walls (Diyarbakır city door). Intervals between positioning points narrowed when topography evidenced a morphological step.
 4. Coring aimed at collecting sediments accumulated in the terraces. The approach was exploratory, before a more complete study of several meters-thick alluvial sequences with a motor-mounted-coring truck device. Exploratory equipment used was hand-manipulated 2 cm-wide-open gauges expected to be able to penetrate easily sandy and gravely sediments (Fig. 4). Despite the thin diameter of the gauges, this hand coring in terraces was extremely difficult.
- 9 First, the upper 50 cm were sampled with a soil auger. This “surface” sample is unsuitable for analyses and dating because it is impacted by agricultural practices. Below -50 cm, gauges were 2.5 cm in diameter screwed to as many 0.5 m or 1 m-long drives. After retrieval, sediments facies and stratigraphy were described on the spot with a 1 cm precision depth. Apart from possible interesting layers (e.g. carbonate crust), sampling was planned to be restricted to ^{14}C dating suitable sediments (organic matter-rich sediments.)

Figure 4 - Members of the geomorphology team in the field, and drawing of the coring equipment



In the office

1. Drawing the stratigraphic log of the coring;
2. Drawing the topographic profile based on the GPS data;
3. Interpreting the LANDSAT TM 2014 composite satellite imagery made available by Google Earth on Internet. Interpretation is based on distinguishing visually surface data captured by the satellite sensors. "Colours" (more or less black and white) and their intensities (from 0 to 256) are considered to record the vegetation cover (type and density) and the soil surface conditions (sediment types and water content). This differentiation between surface colours and colour intensities provides the distinct elements used in the mapping of the terrace scarps and past riverbeds.
4. Drawing a map of terraces (scarps, flats) and former river beds (filled channels). The mapping uses the information delivered by the satellite interpretation described above.

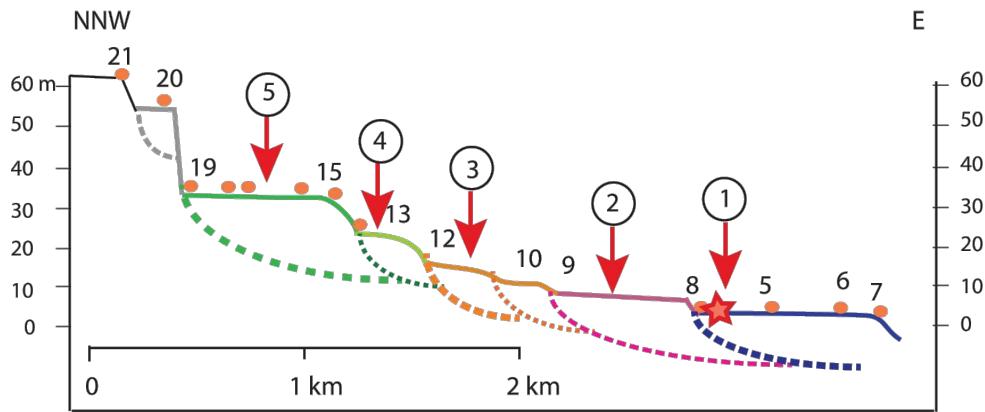
III. Results

Profile of the terraces

- 10 Walking through the right-bank side of the flood valley through the Hevsel gardens, we measured altitudes with a GPS, noting topographical scarps between flatter surfaces.
- 11 The profile obtained exposes an incision/sedimentation succession forming embedded terraces recording major changes in the river dynamics and sediment load. Resulting from a progressive side-translation of the River Tigris south-eastwards (away from the basalt cliff) which contributed up to recent times to their preservation and to the

preservation of the Hevsel Gardens, these stepped terraces also record a history of the valley and of the river, which is rhythmized by periods of sedimentation followed by periods of incision, in a general context of deepening of the valley (Bridgland and Westaway 2008).

Figure 5 - The alluvial terraces embedded in the right bank of the River Tigris valley



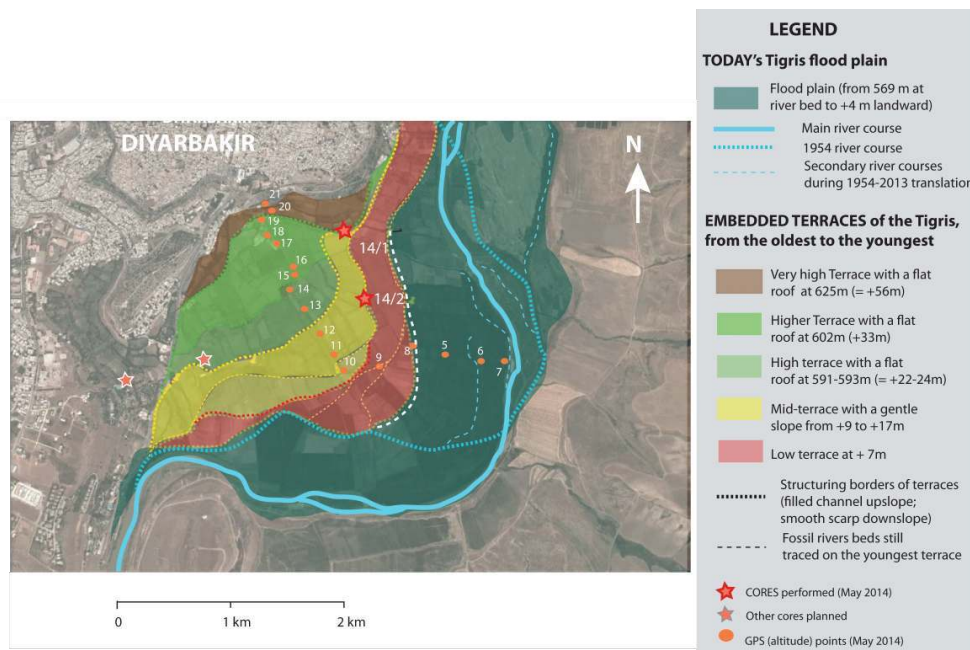
Evidence for major changes in the river dynamics and sediment load through time

- 12 Combining topography and altitude measurements, we obtained the profile shown in Fig. 5. In this profile, the 7 to 21 numbers correspond to the measurement sites, while the 1 to 5 numbers in circles rank upwards the flat surfaces separated by scarps. These five surfaces correspond to five terraces ("T1" to "T5") above today's flood plain ("T0"). "T0" is not shown on Fig. 5.

Mapping right-bank river terraces and river beds

- 13 Confronting the satellite interpretation with data from the GPS-based topographic profile, allowed us to transfer the SRTM-based data on the spot-scale (GPS data) and along the topographic profile to the valley-scale in Fig. 5. A map (Fig. 6) is produced, based on both the field data collection (GPS data and field observation) and the interpretation of satellite imagery. In the legend, each of the 1 to 5 surfaces is defined by its mean altitude relative to that of today's riverbed of the Tigris ("T1"). Besides, "T3" seems to be composed of two sub-levels between + 9 and + 17m (Figs. 5 and 6).

Figure 6 - Map of the River Tigris terraces in the Hevsel gardens



Based on both GPS based topographic profile, and satellite imagery interpretation

Background image: 2014 LANDSAT TM satellite image distributed by Google Earth

Geological cross-section, from valley floor to Diyarbakır city walls (Fig. 7)

- 14 This cross-section is based on GPS-based profile of the terraces, with the addition of exposures of old alluvium (Fig. 3), basement rocks (Fig. 8), volcanic flows (Fig. 9). These exposures outcrop in sections open by roads or any other kind of natural or artificial vertical erosion below the walls, in terraces, in the gardens.

Figure 7 - Schematic geological cross-section, from the River Tigris river channel to the Diyarbakır City wall through the Hevsel Gardens

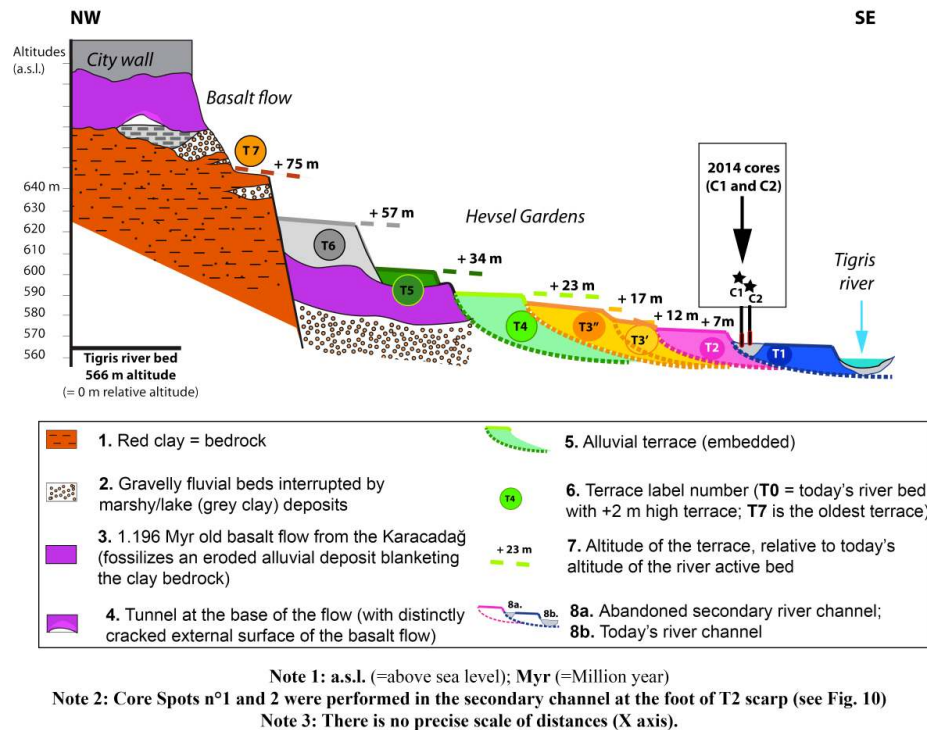
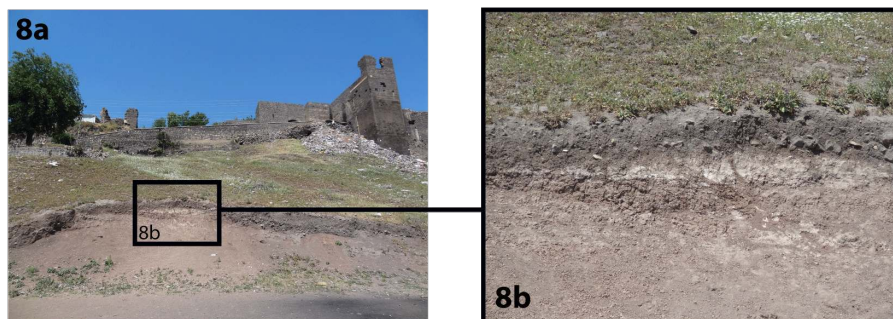


Figure 8 - The oldest substratum rock in the Hevsel Gardens area



8a. Outcrop showing the red clay pertaining to the upper part of the Shelmo formation fossilized by the 1.2 Myr basaltic flow on which the City Wall is constructed (see position on geological cross-section Fig. 7)

8b. Zoom of 8a open section, evidencing a basal reddish facies (low depth lake deposit enriched with continental red -weathered- sediments) covered by a whitish upper facies (deeper lake deposit). The top layer is a slope deposit reworking garbage thrown away from the City walls

Upper Miocene/Lower-Mid Pliocene "Shelmo formation" (lacustrine facies)

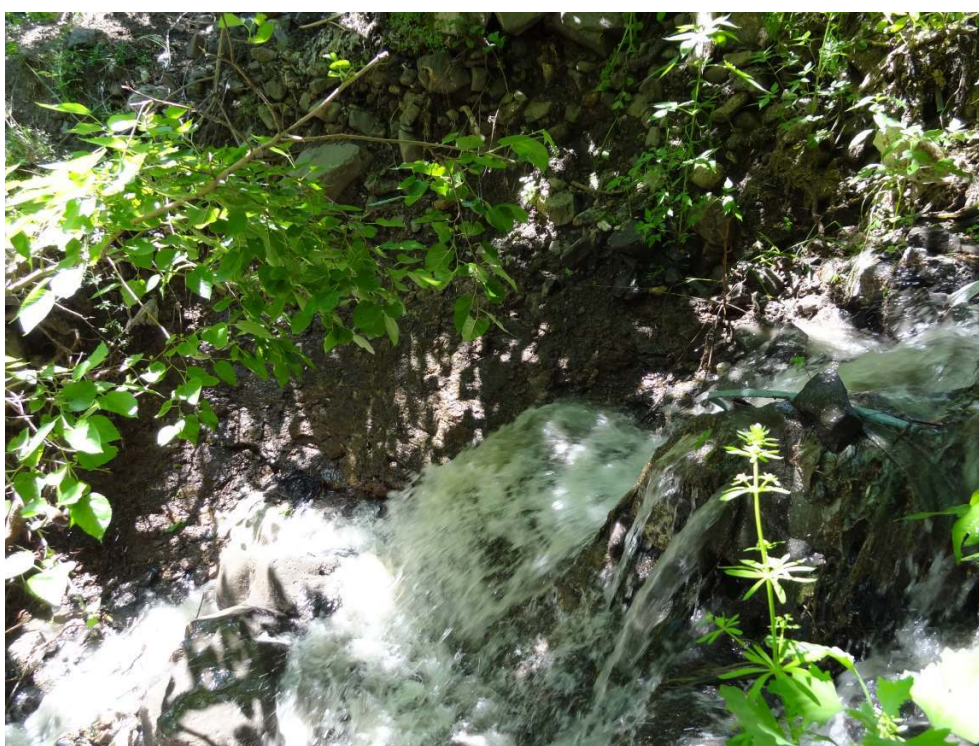
15 Outcrops recognized during our Hevsel Gardens survey produced several surprises:

1. A terrace immediately below the City Walls (GPS point 21 on profile Fig. 5) is not an accumulation terrace as it truncates the substratum (= a reddish clay photographed in Fig. 8). Either it is an erosion terrace, or it is man-made.
2. The oldest terrace at + 56 m (GPS point 20 on the profile Fig. 5, coloured in brown in Fig. 6), is a stepped terrace. In the geomorphologist's "lexicon", a "stepped terrace" is a kind of contrary (with regards to the genetics of the form) to "embedded terrace". The "stepping" is

formed (like here) by the bedrock outcropping below the alluvial deposit constituting the terrace, and within its limiting scarp which is incised in the bedrock (a usual sign of river response to tectonic uplift).

3. In addition, in the gardens at the scarp-limiting terrace T5, a basalt outcrop forces water running over the surface of T5 to flow as a waterfall over the scarp (Fig. 9).
- 16 This outcrop suggests the occurrence, at Diyarbakır, of two distinct basalt flows (Westaway *et al.* 2009), an information that would be very important for the study of the city walls. If correct, this observation means that **a fault controls the right bank of the valley.**
- 17 Terraces survey however suggests that this outcrop in the garden may result from the breaking of the Diyarbakır basalt flow in two parts: one remained at its initial altitude forming the plateau; the other own fell down ca 100 m (in the gardens).

Figure 9 - A basalt outcrop forms a waterfall in the Hevsel gardens



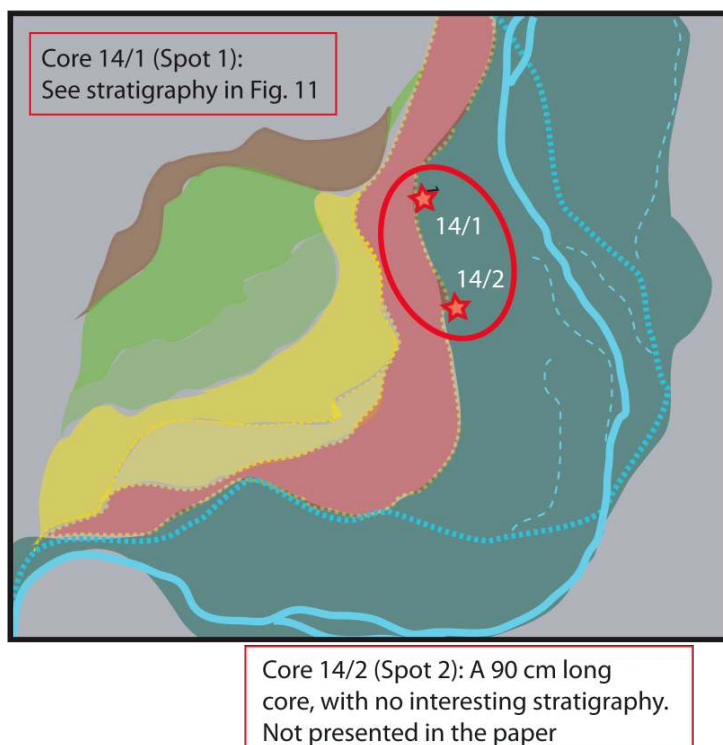
Note: see position of the outcrop on the geological cross-section (Fig. 7)

- 18 The estimated magnitude of the fault movement or fall would be ca 100 m high, possibly more. According to terraces elevations, the possible fault seems to have caused -or partly caused- the 20 m scarp separating T6 from T5 (Fig. 7). The occurrence of a fault breaking the Diyarbakır City lava flow would explain the SE migration of the riverbed, and the terrace stepping, which follows the accentuation of the curve incised by the riverbed south-eastwards from Diyarbakır location.
- 19 This also means that (i) there will be some difficulty to distinguish climatic causes from tectonic causes with regard to the evolution and change of river dynamics; (ii) a well-constrained chronology is needed, which is now expected from coring programmes.

Results of preliminary coring (2 core spots in the Hevsel gardens)

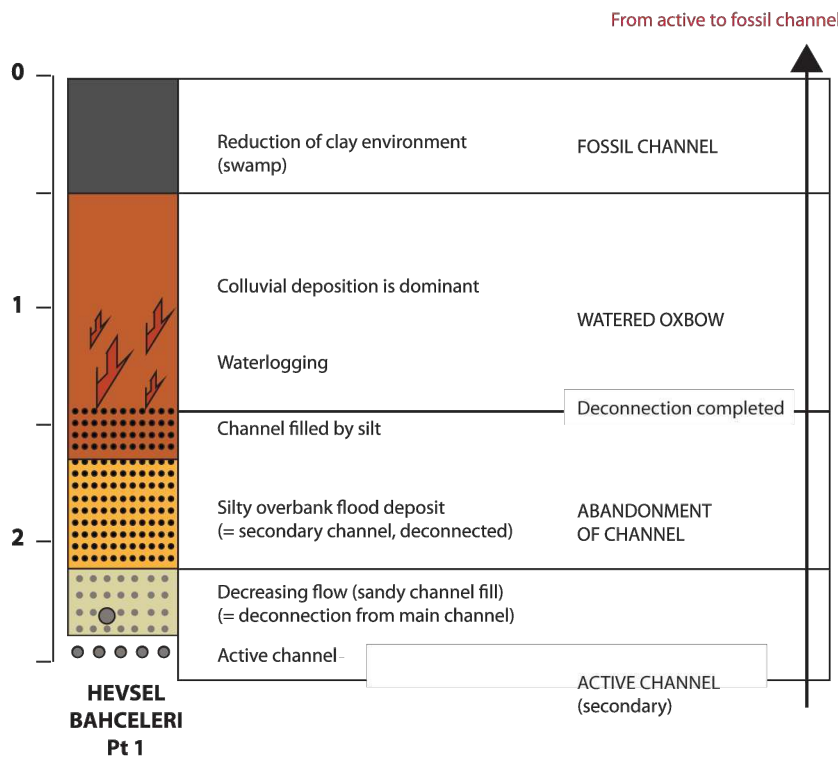
- 20 Sediments in the valley should provide indications about the time and space distribution of the elements composing the hydrosystem in both the recent and remote past. Together with the field study as exposed above, a complementary exploration of sediments was realized by coring the sediments in the valley. In May 2014, two spots were cored in the Hevsel Gardens.

Figure 10 - Location of Core Spots 1 and 2



- 21 According to satellite imagery and to field observation, the two spots were chosen in a channel fill (a former bed of the river: Fig; 10) which has been abandoned at the foot of the scarp limiting “T2” above “T1” (Fig. 5).

Figure 11 - Stratigraphy of the 2.5 m long sequence from Core Spot 1 in Hevsel Gardens



Core retrieved from a secondary channel abandoned at the foot of the **T2** scarp dominating **T1**
 Note: Coordinates of Core spot 2: 37° 54' 11.69"N – 40° 14' 44.69"E

The results concern the stratigraphy and the facies analyses of the sediments cored. Only the sequence from the Core Spot 1 could be interpreted in a time sequence. At Core Spot 2, we have been able to retrieve only 90 cm representing a superficial part of the fill, non-usable for our purposes.

The facies analyses and the stratigraphy of Core Spot 1 (Fig. 11) are typical of the abandonment of a lateral channel (a former active bed): the grain size of the river sediment thinnens upwards. From gravelly at the base, the sediments become sand-enriched; at the end of the process only clay is deposited, in a calm and waterlogged environment favourable to the tree and herb vegetation. The corer could not reach, however, the older sediment formation in which the abandoned channel was formerly incised at the end of the accumulation period of “**T1**”.

- 22 Because of the lack of samples suitable for ¹⁴C dating, both from the sections identified and from the sequences cored, no sample could be sent for dating. Logically, there was no sense in realizing laboratory analyses if the samples could not be set into a chronological frame. Nevertheless, we estimate both “**T1**” terrace, and the cored abandoned river bed, to date Late Holocene, most probably Middle Ages at the earliest, or end of the Little Ice Age after AD 1860.

IV. Plans for 2015 and following years

- 23 In order to achieve our scientific goals, both regarding the Hevsel Gardens and the Tigris River Valley, we plan a series of operations for 2015 and the following years.

Two scopes and approaches at different time and space scales

- 24 On the **valley-scale, i.e. the terraces and valley fills at Diyarbakır, its Gardens** and down to the *palaeo-Tigris valley* (Fig. 12), the most important problems to be answered by further studies of the records of the geomorphological (field studies) and sediment (core studies) archives should head towards reconstructing:
1. in the valley: (i) the terrace ages and modes of formation; (ii) the evolution of the river regime and bed styles, as well as the deposition vs erosion dynamics; (iii) the rapidity of riverbed translation changes over the flood plain; (iv) the role of tectonism and of gypsum dissolution in the overall evolution of the valley at Diyarbakır. Impacts of both factors may have, even today, tremendous impacts on the management (water use, barrages etc.) and future dynamics.
 2. in the Hevsel Gardens: (i) the content and age of the sediments constituting the geological formation and soils sustaining the Diyarbakır gardens; (ii) the impact of man-made terracing on the natural environment; (iii) the evolution of the gardens, e.g. in relation to erosion, flood-related soils...
- 25 On the **regional scale, i.e. the Upper Tigris valley and basin**, we will also search for geomorphological and geological data, which can possibly record the past hydrodynamic and environmental evolution of the River Tigris valley and of its basin (Fig. 13). Geological phenomenon related to tectonism (e.g. Bridgland *et al.* 2007), volcanism (e.g. Westaway *et al.* 2009; Türkecan 2014), climate (e.g. Robinson *et al.* 2006) and karst (Doğan 2005) will be taken into account. As far as reconstructions of climate are concerned, we hope to be able to focus on:
1. the relationships between climatic conditions and the development of human societies: agricultural practices, animal husbandry, centralizing power, resilience to social changes etc., (e.g. Laneri *et al.*, 2012);
 2. the rapid climate changes (the RCCs: e.g. Weninger *et al.* 2009) which are known to be somewhat acquainted with cultural changes, whether on the long-scale (such as Late Neolithic development, choices in production types) or on the short-scales (civilisation collapses at the ends of the 3rd and 2nd mill. BC and the 1st mill. AD: Kuzucuoğlu & Marro 2007).

Figure 12 - The Hevsel Gardens at Diyarbakır: The heart of the River and City histories

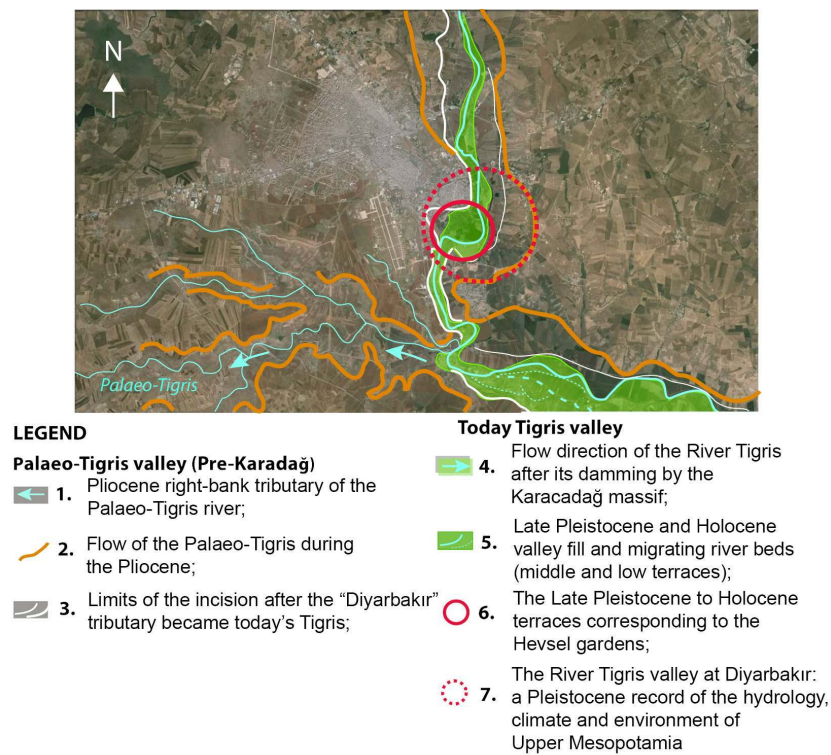
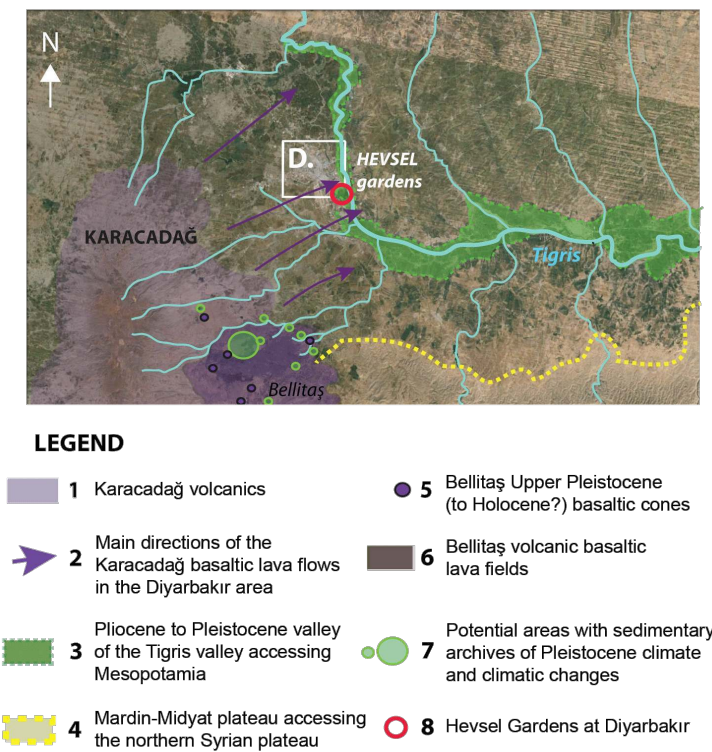


Figure 13 - The River Tigris at Diyarbakır: The meeting place of local to regional geological records



In the field

- 26 Collecting indications about older phases of the river regime and morphology needs coring with a motorized device capable of crossing and sampling thick layers of coarse sediments such as sand (banks, bars, migrating islands, overbank flood deposits) and gravels (river bedload, islands).
- 27 This future coring work in the gardens will be defined according to the profile of the Hevsel terraces obtained in 2014. Accordingly, we shall work on detailing the geomorphologic and geologic (stratigraphy, sedimentology, structure) cross-section of the river valley, from the top of the relief in which the valley is incised to the flood plain.
- 28 The coring will also concern both banks of the valley: the right bank (explored in 2014) from the river through the gardens up to the city; and the left bank of the river, facing Diyarbakır where GPS data collection, mapping terraces etc. will also be performed.

In the laboratory and the office

- 29 Samples from the cores will be analysed in the laboratory. According to aim of analysis and availability of material, the following analyse may be needed: the sedimentology (grain-size, magnetic properties, mineralogy, organic content, soil structure), the geochemistry (inorganic and organic carbon, nitrogen), the biologic proxies (pollen diatoms, molluscs, phytoliths). In addition, C^{14} chronology (on organic matter) and K-Ar dates (on lavas) will be performed, depending on funding.
- 30 Also depending on funding, Master and hopefully Doctorate students must be involved in the research programme, both for various analyses and/or also for data based satellite/GPS data (GIS treatments). These students' researches will concern the geomorphology, as well as the effects of regional and global climate changes. They will especially focus on the succession of events (hydrologic, climatic, geologic) that have impacted the landscapes and the societies (land use, social history, settlements). Among these events, processes related to tectonism (uplifts, earthquakes, fault activity impacts on surface morphology) and karst (existence of any underground gypsum dissolution impacts?) must be explored with attention.

Conclusion

- 31 Environment and environmental systems have memories. Our researches ambition studying the objects capable of retaining and delivering to us parts of this memory. What happens today to the river and valley systems at Diyarbakır depends of course of today's Man's decisions and deeds. But it fundamentally depends on the history of the system. Forgetting the past in the analysis of dynamic systems, is more than an error. Our responsibility towards our future, and the future of environmental systems that sustain us, makes it a fault. If we want to understand what happened in the Tigris Valley and the Diyarbakır Gardens since at least the Assyrian Empire, i.e. the time when the gardens are first evoked in cuneiform texts 3000 years ago, we must thus absolutely think inside the *temps long* (the "long duration" approach: see Braudel 1987). The memory of the system indeed, i.e. the century to pluri-millennium-scaled changes imposed by the substratum context, the volcanic activity (e.g. see Annex 1), the climate conditions, the deposition

and erosion dynamics, the tectonic uplift and associated earthquakes, the impacts of past human activities and management etc... (e.g. see references in Annex 2), strongly constrains the dynamics and the future of the environment.

- 32 **The Hevsel Gardens** are such objects capable of containing information about the “temps long” of the City of Diyarbakır. Besides, **the terraces sustaining the Hevsel Gardens** also record hydrological and climatic changes in the valley, from the Last Glacial¹ to the Holocene, until today.
- 33 To date, no age, no stratigraphy, no sedimentology are available for the Hevsel gardens and the Tigris terraces at Diyarbakır. Figures 5 to 7 show clearly that defining and dating the landscapes previous to the gardens, or during the activity period of the gardens need coring all terraces.
- 34 Our 2014 coring experience shows that future coring in recent and old alluvium must be performed with a motorized corer, which will be able to break through gravel layers. Only this way will we be able to reach layers and deposits from different periods in the formation of today’s river flood plain and terraces.
- 35 **In the Upper Tigris watershed**, we plan to study the geomorphologic and climatic records, which will provide for the wider space (regional) and time (Braudelian *temps long*) of the history of environment in the region and in the river’s life span.
- 36 In the frame of this history of the river basin, our expected results should enlighten periods of stability and instability in the fluvial dynamics. Such a reconstruction must be set in relation to the occupation of the region by human societies. Indeed, due to its primary role in the appearance of agriculture, the whole Tigris basin is critical for the humanity’s history (Fig. 1) (e.g. Karadoğan and Kozbe 2013), from the Pre-Pottery Neolithic period (PPN: e.g. Özdoğan 2007; Kuzucuoğlu 2014) to the Middle Ages (Ottoman Empire), from the end of the Younger Dryas (11400 years ago to the 8.2 cal BP rapid event (e.g. Weninger *et al.* 2009), from the Akkadian Empire at the 4.2 ka cal BP climatic crisis to the end of Hittite Empire during the 3.2 ka cal BP climatic crisis, from the Assyrian wars to the arrival and retreat of the Roman Empire, from the Byzantine to the arrival of the Seljuks... Our time-scope thus covers in the basin: (i) the Last Ice Age (especially since its maximum 35-16.000 years ago: e.g. Sarıkaya *et al.* 2011), (ii) the Late Glacial, which saw the first Fertile Crescent human settlements in the Upper Tigris basin, (iii) the Holocene, when this region became a centre for the development of plant and animal domestication techniques and of urbanisation as well as State formation.

BIBLIOGRAPHY

- Algaze, G.; Breuninger, R.; Lightfoot, C.; Rosenberg, M., (1991). “The Tigris-Euphrates Archaeological Reconnaissance Project: A preliminary report of the 1989-1990 Seasons”, *Anatolica* XVII p. 175-240.
- Braudel, F., (1987). “Histoire et Sciences Sociales : La longue durée”, *Réseaux*, 5(27), p. 7-37. URL: <http://dx.doi.org/10.3406/reso.1987.1320>.

- Bridgland, D.R.; Demir, T.; Seyrek, A.; Pringle, M.; Westaway, R.; Beck, A.R.; Rowbotham, G.; Yurtmen, S., (2007). "Dating Quaternary volcanism and incision by River Tigris at Diyarbakır, Southeast Turkey", *Journal of Quaternary Sciences* 22, p. 387-393. URL: <http://dx.doi.org/10.1002/jqs.1074>.
- Bridgland, D.; Westaway, R., (2008). "Climatically controlled river terrace staircases: a worldwide Quaternary phenomenon", *Geomorphology* 98, p. 285-315. URL: <http://dx.doi.org/10.1016/j.geomorph.2006.12.032>.
- Doğan, U., (2005). "Holocene fluvial development of the Upper Tigris Valley (Southeastern Turkey) as documented by archaeological data", *Quaternary International* 129, p. 75-86. URL: <http://dx.doi.org/10.1016/j.quaint.2004.04.008>.
- Karadoğan, S. and Kozbe, G., (2013). "Yukarı Dicle Havzasının (Batman-Bismil Arası) Jeomorfolojik Özellikleri ve Arkeolojik Yerleşme/Buluntu Yerlerinin Dönemler Boyunca Mekan Etkileşimleri", In Öner, E. (ed.), *Profesör Doktor İlhan Kayan'a Armağan*, İzmir, Ege Üniversitesi, p. 540-564. URL: <http://www.dicle.edu.tr/a/skaradogan/eser/f2.pdf>.
- Kuzucuoğlu C.; Dörfler W.; Kunesch S.; Goupille F., (2011). "Mid- to late-Holocene climate change in central Turkey: the Tecer lake record", *The Holocene*, 21(1), p. 173-188. URL: <http://dx.doi.org/10.1177/0959683610384163>.
- Kuzucuoğlu, C.; Fontugne, M. and Muralis, D., (2004). "Holocene terraces in the Middle Euphrates valley, between Halfeti and Karkemish (Gaziantep, Turkey)", *Quaternaire* 15(1-2), p. 195-206. URL: <http://dx.doi.org/10.3406/quate.2004.1767>.
- Kuzucuoğlu, C. and Marro, C. (eds.), (2007). *Sociétés humaines et changement climatique à la fin du troisième millénaire : une crise a-t-elle eu lieu en Haute Mésopotamie?*, Actes du Colloque de Lyon (5-8 décembre 2005), Varia Anatolica XIX, IFEA / De Boccard, Istanbul / Paris. URL : http://www.persee.fr/issue/anatv_1013-9559_2007_act_19_1.
- Kuzucuoğlu C., (2014). "Contextes régionaux du Néolithique en Anatolie: aspects environnementaux et chronologiques", In Arnaud-Fassetta, G. and Carcaud, N. (eds), *La géoarchéologie française au XXI^e siècle/French geoarcheology in the 21st century*, Paris, CNRS Press, p. 131-146.
- Laneri, N.; Pfälzner, P. and Valentini S. (eds.), (2012). *Looking North The Socioeconomic Dynamics of Northern Mesopotamian and Anatolian Regions during the Late Third and Early Second Millenium BC*. Studien zur Urbanisierung Nordmesopotamiens Band 1, Wiesbaden, Harrassowitz.
- Özdoğan, A., (2007). "Çayönü", In Özdoğan, M. and Başgelen, N. (eds.), *Anadolu'da Uygarlığın Doğuşu ve Avrupa'ya Yayılımı: Türkiye'de Neolitik Dönem, Yeni Kazılar, Yeni Bulgular*, İstanbul, Arkeoloji ve Sanat Yay., p. 57-97.
- Parker, B.J. and Creekmore, A., (2002). "The Upper Tigris Archaeological Research Project: A Final Report from the 1999 Field Season", *Anatolian Studies*, 52, p. 19-74. URL: <http://dx.doi.org/10.2307/3643077>.
- Robinson, S.A.; Black, S.; Sellwood, B.; Valdes, P.J., (2006). "A review of palaeoclimates and palaeoenvironments in the Levant and Eastern Mediterranean from 25,000 to 5000 years BP: setting the environmental background for the evolution of human civilization", *Quaternary Science Reviews* 25, p. 1517-1541. URL: <http://dx.doi.org/10.1016/j.quascirev.2006.02.006>.
- Sarıkaya, M.A.; Çiner, A. and Zreda, M., (2011). "Quaternary Glaciations of Turkey", In Ehlers, J.; Gibbard, P.L.; Hughes, P.D. (eds.), *Developments in Quaternary Science* 15, p. 393-403. URL: <http://dx.doi.org/10.1016/B978-0-444-53447-7.00030-1>.

Türkecan A., (2014). *Türkiye Volkanitleri. Güneydoğu Anadolu Bölgesi Volkanitleri* (Böl. 9). In MTA Pub (Ankara), p. 257-266.

Weninger, B.; Clare, L.; Rohling, E.; Bar-Yosef, O.; Böhner, U.; Budja, M.; Bundschuh, M.; Feurdean, A.; Gebe, H.G.; Jöris, O.; Linstädter, J.; Mayewski, P.; Mühlenbruch, T.; Reingruber, A.; Rollefson, G.; Schyle, D.; Thissen, L.; Todorova, H.; Zielhofer, C., (2009). "The Impact of Rapid Climate Change on prehistoric societies during the Holocene in the Eastern Mediterranean", *Documenta Praehistorica*, XXXVI, p. 7-59. URL: <http://dx.doi.org/10.4312/dp.36.2>.

Westaway, R.; Guillou, H.; Seyrek, A.; Demir, T.; Bridgland, D.; Scaillet, S.; Beck, A.; (2009). "Late Cenozoic surface uplift, basaltic volcanism, and incision by the River Tigris around Diyarbakır, SE Turkey", *International Journal of Earth Sciences* 98, p. 601–625. URL: <http://dx.doi.org/10.1007/s00531-007-0266-z>.

Kuzucuoğlu, C. and Marro, C. (eds.), (2007). *Sociétés humaines et changement climatique à la fin du troisième millénaire: une crise a-t-elle eu lieu en Haute Mésopotamie?*, Actes du Colloque de Lyon (5-8 décembre 2005), Varia Anatolica XIX, IFEA / De Boccard, Istanbul / Paris. URL: http://www.persee.fr/issue/anatv_1013-9559_2007_act_19_1.

Weninger, B.; Clare, L.; Rohling, E.; Bar-Yosef, O.; Böhner, U.; Budja, M.; Bundschuh, M.; Feurdean, A.; Gebe, H.G.; Jöris, O.; Linstädter, J.; Mayewski, P.; Mühlenbruch, T.; Reingruber, A.; Rollefson, G.; Schyle, D.; Thissen, L.; Todorova, H.; Zielhofer, C., (2009). "The Impact of Rapid Climate Change on prehistoric societies during the Holocene in the Eastern Mediterranean", *Documenta Praehistorica*, XXXVI, p. 7-59. URL: <http://dx.doi.org/10.4312/dp.36.2>.

APPENDIXES

The Karacadağ Volcanism and Its Impact on the Tigris Valley in the Area of Diyarbakır. Preliminary state of the art

It is important to integrate volcanism in our study for three main reasons:

1. volcanism not only produces interesting forms, but it is capable of modifying other landforms in extreme manners. Basaltic flows especially are capable of filling-in river valleys; they can also force changes in river flow directions when they cut (and dam) a valley, sometimes definitively; they preserve geological formations and old landforms below them as they are very resistant to later erosion;
2. because in-fillings and dammings cause river flow interruptions, they often also produce lakes. Lake sediments and levels are good indicators of environment/climatic changes;
3. it is easy (although expensive) to date basaltic flows. Such flows (and other eruptive products) are thus very useful for setting chronological frames to climatic and environmental events in the area (see below).

Presentation

West of Diyarbakır, the Karacadağ basaltic shield volcano (1945 m) is the largest volcano of Turkey (and the Middle East?). It is formed by an abundant fissural activity that

emitted lavas forming today a N-S oriented accretion cupola-shaped shield west of Diyarbakır (Fig. 13). The longest of the flows eastwards reached the area of Diyarbakır and of the River Tigris present valley where a flow remain forms, for example, a high promontory overlooking the river valley left bank. Two periods of activity are known: (i): 11 to 10 Million years (Ma), i.e. Upper Miocene²; (ii) 6.7-6.6 Ma, i.e. Transition Mio-Pliocene³; (iii) 1.9 Ma to 100 ka (ka = 100,000 years), i.e. Quaternary⁴ (Türkecan 2015).

The basaltic lava flows below the City walls of Diyarbakır

Several authors, from Haksal (1981) to Westaway *et al.*, (2009), have studied the Quaternary activity of the volcano. This activity produced many cones and craters which top today the preceding Miocene lava accumulation on the N-S backbone of the shield. Cones and craters emitted very fluid basaltic flows which flow eastwards in direction of today's River Tigris valley. With ages of 1.2 to 1.07 Ma (Westaway *et al.* 2009), the Diyarbakır flows belong to an early phase of this Quaternary activity. These ages pre-date very coarse alluvium fossilized below the basaltic flow (visible at Mardin Gate in Diyarbakır: Fig. 7). The Early Pleistocene⁵ alluvial deposits belonged to a sheet-flow type hydraulic system that can be visualized when looking at similar (although later) alluvium pieces blanketing the plateau surface formed by these very lava flows east of Diyarbakır. When the Diyarbakır flows were emitted, the collector-drain transporting the pre-basalt alluvium was located roughly at the same place as today's River Tigris (Fig. 13), although it may have had a flow direction different from that of today. Today's River Tigris flows now ~60-70 m below the floor of the Early Pleistocene alluvium fossilized by the lava flow forming Diyarbakır City eastern cliffs (Fig. 7).

The sedimentary-volcanic succession at the right bank of the River Tigris valley south of Diyarbakır

South of Diyarbakır, the river crosses a deep and narrow gorge incised into a geological series topped on both sides by the Early Pleistocene basalt flows. Outflowing from the gorge, the river turns eastwards, forming an elbow eastward (Fig. 14). This elbow was triggered during Upper Miocene or Upper Pliocene (?) by the building up of the Karacadağ volcano which is obviously set over a former drain used by a palaeo-river Tigris flowing west toward a palaeo-Euphrates (Fig. 14). According to dates published in Westaway *et al.*, (2009), these flows are Middle Pleistocene aged (600-430 ka ago). They cover a sedimentary series formed by alternations of coarse alluvium and red clays, which record a lake-like environment with a highly varying level (Fig. 15). This lake landscape and surrounding alluvial fans thus possibly dates Early Pleistocene. It may have resulted from the hydraulic disorganization created by the lava dams across the west-oriented palaeo-Tigris. The top of this sedimentary series is positioned ~21-22 m above today's riverbed, meaning that only the last 20m of the River Tigris incision dates Middle and Upper Pleistocene. This observation and calculation may not be transposable upstream the gorge since, if we are right in assuming that there is only one lava flow at Diyarbakır, a fault-movement contributed to 20m of the 70m apparent incision of the river at Diyarbakır.

Figure 14 - The elbow of the Tigris River where the river abandons its pre-Karacadağ valley



Figure 15 - Mio-Pliocene sedimentary deposits fossilized by the Middle Pleistocene lava flows



Sections on the right bank of the River Tigris elbow south of Diyarbakır

A Preliminary Exhaustive Reference List applied to the Upper Tigris, classified by main subject

Geology and Geomorphology in the River Tigris valley and basin (Diyarbakır region and related references)

Arger, J.; Mitchell, J.; Westaway, R., (2000). "Neogene and Quaternary volcanism of Southeastern Turkey". In Bozkurt, E.; Winchester, J.A.; Piper, J.D.A. (eds.), *Tectonics and Magmatism of Turkey and the Surrounding Area*. Geological Society, London, Special Publication 173, p. 459-487. URL: <http://dx.doi.org/10.1144/GSL.SP.2000.173.01.22>.

Bridgland, D.R.; Demir, T.; Seyrek, A.; Pringle, M.; Westaway, R.; Beck, A.R.; Rowbotham, G.; Yurtmen, S., (2007). "Dating Quaternary volcanism and incision by River Tigris at Diyarbakır, Southeast Turkey", *Journal of Quaternary Sciences* 22, p. 387-393. URL: <http://dx.doi.org/10.1002/jqs.1074>.

- Canbolat, E., (2005). Karacadağ (Diyarbakır) volkan jeomorfolojisi. Yüksek Lisans Tezi, İstanbul Üniversitesi Sosyal Bilimler Enstitüsü Coğrafya Anabilim Dalı., 83 p., (Unpub.).
- DSI, (1979). *Yukarı Dicle Havzası Hidrojeolojik Etüd Raporu*. DSI, Ankara. 113 p.
- Doğan, U., (2005). "Land subsidence and caprock dolines caused by subsurface gypsum dissolution and the effect of subsidence on the fluvial system in the Upper Tigris Basin (between Bismil-Batman, Turkey)", *Geomorphology* 71, p. 389-401. URL: <http://dx.doi.org/10.1016/j.geomorph.2005.04.010>.
- Doğan, U., (2005). "Holocene fluvial development of the Upper Tigris Valley (Southeastern Turkey) as documented by archaeological data", *Quaternary International* 129, p. 75-86. URL: <http://dx.doi.org/10.1016/j.quaint.2004.04.008>.
- Ercan, T.; Fujitani, T.; Matsuda, J.; Notsu, K.; Tokel, S.; Ui, T., (1990). "Doğu ve Güneydoğu Anadolu Neojen-Kuvaterner volkanitlerine ilişkin yeni jeokimyasal, radyometrik ve izotopik verilerin yorumu", *Maden Tetkik ve Arama Dergisi*. 110, p. 143-164. URL: http://bulletin.mta.gov.tr/mtadergi/110_10.pdf.
- Haksal, A., (1981). *Petrographie und Geochemie des Schildvulkans Karacadağ*. PhD. Thesis, Hamburg Univ., (Unpub.)
- Karadoğan, S. and Kozbe, G., (2013). "Yukarı Dicle Havzasının (Batman-Bismil Arası) Jeomorfolojik Özellikleri ve Arkeolojik Yerleşme/Buluntu Yerlerinin Dönemler Boyunca Mekan Etkileşimleri", In Öner, E., (ed.), *Profesör Doktor İlhan Kayan'a Armağan*, Ege Üniversitesi, İzmir, p. 540-564. URL: <http://www.dicle.edu.tr/a/skaradogan/eser/f2.pdf>.
- Kuzucuoğlu, C., (2002). "Preliminary observation on the Tigris Valley terraces between Bismil and Batman", In Tuna, N. and Velibeyoğlu, J. (eds.), *Salvage Project of the Archaeological Heritage of the Ilisu-Carchemish Dam Reservoirs Activities in 2000*, METU, Ankara, p. 759-771.
- Kuzucuoğlu, C., (2003). "The geomorphological setting of Kavusan Höyük in the Tigris valley near Bismil (Diyarbakır) and its significance for Holocene evolution of the river dynamics", In Tuna, N. and Velibeyoğlu, J. (eds.), *4th TAÇDAM Report*, Publications ODTÜ, Ankara.
- Lustrino, M.; Keskin, M.; Mattioli, M.; Lebedev, V.A.; Chugaev, A.; Sharkov, E.; Kavak, O., (2010). "Early activity of the largest Cenozoic shield volcano in the circum-Mediterranean area: Mt. Karacadağ, SE Turkey", *European Journal of Mineralogy* 22, p. 343-62. URL: <http://dx.doi.org/10.1127/0935-1221/2010/0022-2024>.
- Salvati, R. and Sasowsky, I.D., (2002). "Development of collapse sinkholes in areas of groundwater discharge", *Journal of Hydrology* 264, p. 1-11. URL: [http://dx.doi.org/10.1016/S0022-1694\(02\)00062-8](http://dx.doi.org/10.1016/S0022-1694(02)00062-8).
- şaroğlu, F. and Emre, Ö., (1987). "Karacadağ volkanitlerinin genel özellikleri ve Güneydoğu Anadolu otoktonundaki yeri", *Türkiye 7.Petrol Kongresi Bildiriler Kitabı*, p. 384-391.
- Turhan, N.; Balcı, V.; Günay, Y., (2002). "1/500.000 Ölçekli Türkiye Jeoloji Haritası Diyarbakır Paftası", *Türkiye 1/500.000 Ölçekli Jeoloji Haritaları* 17, In Şenel, M. (ed.), MTA Yay., Ankara.

Türkecan, A., (2014). *Türkiye Volkanitleri. Güneydoğu Anadolu Bölgesi Volkanitleri* (Böl. 9), MTA Pub, Ankara, p. 257-266.

Westaway, R.; Guillou, H.; Seyrek, A.; Demir, T.; Bridgland, D.; Scaillet, S.; Beck, A., (2009). “Late Cenozoic surface uplift, basaltic volcanism, and incision by the River Tigris around Diyarbakır, SE Turkey”, *International Journal of Earth Sciences* 98, p. 601-625. URL: <http://dx.doi.org/10.1007/s00531-007-0266-z>.

Sediments and terraces, archives of climate

Bridgland, D.; Westaway, R., (2008). “Climatically controlled river terrace staircases: a worldwide Quaternary phenomenon”, *Geomorphology* 98, p. 285-315. URL: <http://dx.doi.org/10.1016/j.geomorph.2006.12.032>.

Cullen, H.M.; deMenocal, P., (2000). “North Atlantic influence on Tigris-Euphrates Streamflow”, *International Journal of Climatology* 20, p. 853-863. URL: [http://dx.doi.org/10.1002/1097-0088\(20000630\)20:8<853::AID-JOC497>3.0.CO;2-M](http://dx.doi.org/10.1002/1097-0088(20000630)20:8<853::AID-JOC497>3.0.CO;2-M).

Kehl, M.; Skowronek, A., (2009). “Nature and age of Late Quaternary basin fill deposits in the Basin of Persepolis/Southern Iran”, *Quaternary International* 196, p. 57-70. URL: <http://dx.doi.org/10.1016/j.quaint.2008.06.007>.

Kuzucuoğlu, C., (2004). “Late Pleistocene environmental changes in Anatolia: records from sediment sequences and geomorphological studies”, In Algan, O. and Mater, B. (eds), *Earthsystems*, Istanbul Univ. Press, p. 19-27.

Kuzucuoğlu, C., (2006). “Presentation of the geology and geomorphology of the Euphrates Valley in the surroundings of Zeugma”, In R. Ergeç (Ed), *Zeugma, from Past to Future*, Gaziantep, p. 111-117 and CXXV-CXXIX.

Kuzucuoğlu, C., (2007). “Climatic and environmental trends during the Third Millenium BC in Upper Mesopotamia”, In Kuzucuoğlu, C. and Marro, C. (eds.), *Sociétés humaines et changement climatique à la fin du troisième millénaire: une crise a-t-elle eu lieu en Haute Mésopotamie?*, Actes du Colloque de Lyon (5-8 décembre 2005), Varia Anatolica XIX, IFEA / De Boccard, Istanbul / Paris, p. 459-480. URL: http://www.persee.fr/doc/anatv_1013-9559_2007_act_19_1_1113.

Kuzucuoğlu, C., (2013). “Geomorphology of the Melendiz River in Cappadocia (Turkey): setting of Pre-Pottery Neolithic sites of Aşıklı and Musular, and climate reconstruction during the onset of the Holocene”, *Geografia Fisica e Dinamica Quaternaria*, 36, p. 95-105. URL: <http://dx.doi.org/10.4461/GFDQ.2013.36.7>.

Kuzucuoğlu, C.; Karabiyikoğlu, M.; Fontugne, M.; Pastre, J-F.; Ercan, T., (1997). “Environmental changes in Holocene lacustrine sequences from Karapınar in the Konya Plain (Turkey)”, In Dalfes, N.; Kukla, G.; Weiss, H. (eds), *Third Millenium BC Climate Change and Old World Collapse*, NATO ASI Series, 149, p. 451-163. URL: http://dx.doi.org/10.1007/978-3-642-60616-8_18.

Kuzucuoğlu, C.; Bertaux, J.; Black, S.; Denèfle, M.; Fontugne, M.; Karabiyikoğlu, M.; Kashima, K.; Limondin-Lozouet, N., (1999). “Reconstruction of climatic changes during the Late Pleistocene, based on sediment records from the Konya Basin (Central Anatolia, Turkey)”, *Geological Journal* 34, p. 175-198. URL: [http://dx.doi.org/10.1002/\(SICI\)1099-1034\(199901/06\)34:1/2<175::AID-GJ820>3.0.CO;2-M](http://dx.doi.org/10.1002/(SICI)1099-1034(199901/06)34:1/2<175::AID-GJ820>3.0.CO;2-M).

- Kuzucuoğlu, C.; Fontugne, M.; Muralis, D., (2004). "Holocene terraces in the Middle Euphrates valley, between Halfeti and Karkemish (Gaziantep, Turkey)", *Quaternaire* 15, 1-2, p. 195-206. URL: <http://dx.doi.org/10.3406/quate.2004.1767>.
- Kuzucuoğlu, C.; Christol, A.; Muralis, D.; Dogu, A-F.; Akköprü, E.; Fort, M.; Brunstein, D.; Zorer, H.; Fontugne, M.; Scaillet, S.; Reyss, J-L.; Guillou, H.; Karabıyıkoglu, M., (2010). "Formation of the Upper Pleistocene terraces of Lake Van (Turkey)", *Journal of Quaternary Science* 25(7), p. 1124-1137. URL: <http://dx.doi.org/10.1002/jqs.1431>.
- Kuzucuoğlu, C.; Dörfler, W.; Kunesch, S.; Goupille, F., (2011). "Mid-Holocene climate change in central Turkey: the Tecer lake record", *The Holocene*, 21(1), p. 173-188. URL: <http://dx.doi.org/10.1177/0959683610384163>.
- Sarıkaya, M.A.; Çiner, A.; Zreda M., (2011). "Quaternary Glaciations of Turkey", In Ehlers, J.; Gibbard, P.L.; Hughes, P.D. (eds.), *Developments in Quaternary Science* 15, p. 393-403. URL: <http://dx.doi.org/10.1016/B978-0-444-53447-7.00030-1>.

Past climates and human societies

- Dow, G.; Olewiler, N.; Reed, C., (2005). "The transition to agriculture: Climate reversals, population density, and technical change", *Economic History* 0509003, Econ WPA. URL: <http://econpapers.repec.org/RePEc:sfu:sfudps:dp05-01>.
- Kuzucuoğlu, C., (2014). "The regional scale of the Neolithic in Anatolia: Issues about chronology and environmental contexts", In G. Arnaud-Fassetta and N. Carcaud (Eds), *Important Orientations in French Research in the Field of Geoarchaeology*, CNRS Publications.
- Messerli, B.; Grosjean, C.; Hofer, T.; Nunez, L.; Pfister, C., (2000). "From nature-dominated to human-dominated environmental changes", *Quaternary Science Reviews* 19, p. 459-479. URL: [http://dx.doi.org/10.1016/S0277-3791\(99\)00075-X](http://dx.doi.org/10.1016/S0277-3791(99)00075-X).
- Middleton, G.D., (2012). "Nothing Lasts Forever: Environmental Discourses on the Collapse of Past Societies", *Journal of Archaeological Research* 20, p. 257-307. URL: <http://dx.doi.org/10.1007/s10814-011-9054-1>.
- Riehl, S., (2012). "Variability in ancient Near Eastern environmental and agricultural development", *Journal of Arid Environments* 86, p. 113-121. URL: <http://dx.doi.org/10.1016/j.jaridenv.2011.09.014>.
- Robinson, S.A.; Black, S.; Sellwood, B.; Valdes, P.J., (2006). "A review of palaeoclimates and palaeoenvironments in the Levant and Eastern Mediterranean from 25,000 to 5000 years BP: setting the environmental background for the evolution of human civilization", *Quaternary Science Reviews* 25, p. 1517-1541. URL: <http://dx.doi.org/10.1016/j.quascirev.2006.02.006>.
- Telelis, I.G., (2005). "Historical-Climatological Information from the Time of the Byzantine Empire (4th-15th Centuries AD)", *History of Meteorology* 2, p. 41-50. URL: <http://www.meteohistory.org/2005historyofmeteorology2/04telelis.pdf>.

Tigris Archaeology

Algaze, G., (1989). "A New Frontier: First Results of the Tigris-Euphrates Archaeological Reconnaissance Project", *Journal of Near Eastern Studies* 48(4), p. 241-281. URL: <http://www.jstor.org/stable/544449>.

Algaze, G.; Breuninger, R.; Lightfoot, C.; Rosenberg, M., (1991). "The Tigris-Euphrates Archaeological Reconnaissance Project: A preliminary report of the 1989-1990 Seasons", *Anatolica* XVII, p. 175-240.

Hauptmann, H., (2002). "Upper Mesopotamia in its regional context during the early Neolithic", In Gérard, F. and Thissen, I. (eds.), *The Neolithic of Central Anatolia: internal developments and external relations during the 9th-6th millennia cal. BC*, Istanbul, Ege Yay., p. 263-75.

Laneri, N.; Pfälzner, P.; Valentini S. (eds.), (2012). *Looking North The Socioeconomic Dynamics of Northern Mesopotamian and Anatolian Regions during the Late Third and Early Second Millenium BC*. Studien zur Urbanisierung Nordmesopotamiens Band 1, Wiesbaden.

Özdoğan, A., (2007). "Çayönü", In Özdoğan, M. and Başgelen, N. (eds.) *Anadolu'da Uygarlığın Doğuşu ve Avrupa'ya Yayılımı: Türkiye'de Neolitik Dönem, Yeni Kazılar, Yeni Bulgular*, Istanbul, Arkeoloji ve Sanat Yay., p. 57-97.

Özkaya, V. and Coskun, A., (2009). "Körtik Tepe, a new Pre-Pottery Neolithic A site in southeastern Anatolia", *Antiquity* 83 (320). URL: <http://antiquity.ac.uk/projgall/ozkaya320/>.

Parker, B.J. and Creekmore, A., (2002). "The Upper Tigris Archaeological Research Project: A Final Report from the 1999 Field Season", *Anatolian Studies*, 52, p. 19-74. URL: <http://dx.doi.org/10.2307/3643077>.

NOTES

1. The Last Glacial: 115,000 to 15,000 years ago; the Late Glacial: 15,000 to 11,400 years ago; the Holocene: 11,400 years ago to today.
2. Upper Miocene is dated 11.6 to 5.3 Ma ago.
3. 5.3 to 2.6 Ma ago
4. The words "Quaternary" and "Pleistocene" are equivalent
5. Plio-Pleistocene transition is dated 2.6-1.9 Ma ; Early Pleistocene is dated 1.9 - 0.5 M; Middle Pleistocene is dated 0.5 to 0.12 ka; Upper Pleistocene is the period covering the last 115 ka.

ABSTRACTS

Environment and environmental systems have memories which become heritages common to several civilizations. The river and valley systems at Diyarbakır are such a heritage, whose future

depends first today on our decisions and deeds, but also on the history of the system dynamics. This history is recorded in the terraces stretching along the river flood plain, and in the relationships between the river and the substratum that it incises. In 2014, we investigated the Hevsel gardens, which correspond to river terraces stepping at the foot of the city walls (right bank), but also at the foot of the plateau over which the University is built (left bank). The results presented here fix the general context of our further studies (2015): 1) a topographic profile of the terraces from the foot of the City walls to today's active bed; 2) the map of the terraces on the right bank of the river at Diyarbakır (corresponding to Hevsel gardens); 3) a preliminary geological section from the City to the river; 4) the stratigraphy of a sediment core retrieved from an abandoned channel of the river in one of its youngest terraces. Finally we expose our plans for future studies, which will investigate not only (1) deep cores to be set in terraces of different ages at the Diyarbakır location, but also other parts of the watershed such as (2) the remnants of a river network allowing the Tigris to join the Euphrates West of the Karacadağ volcanic massif, and (3) possible sediment archives contained in the collapsed bottom of dolines in the Bismil vicinity.

INDEX

Geographical index: Diyarbakır, Hevsel gardens

Keywords: Holocene, Tigris, Terraces

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