Understanding how the climate change impacted human societies in the past has become a primary research topic in archaeology. Usage of available proxies for climate reconstruction (speleothems, lake sediments, etc.) enables, in a correlative approach, to identify interconnections between the recorded climate fluctuations and developments in past societies. However, the proxies available so far have relatively low temporal resolution and are not necessarily available for the most densely populated region. Additionally, the data miss to document how people themselves were affected as biological organisms by any of these climate fluctuations. Therefore, fully reliable causal association of changing climate with any shifts in human behaviour or material culture remains very difficult if not impossible.

The most common climatic proxy is the proportion of stable oxygen isotopes, ^{18}O and ^{16}O, expressed as the $\delta^{18}O$ value. With raising temperature, water evaporation rate increases and as the water particles with lighter isotope ^{16}O evaporate easier, the $\delta^{18}O$ value in remaining water is higher. Through water consumption this isotopic signature affects the body water composition and is incorporated also in forming human enamel. Tracing the changes in enamel incremental layers enables insights into changes in temperature and humidity during the several years of the tooth forming period early in life.

Within this project we will develop and test a new approach to research climate variability in the past, based on direct reconstruction of short-term climate fluctuations locally at the archaeological sites using high-resolution sequences of $\delta^{18}O$ measurements in the incremental layers of human enamel. Additionally, we will use also other biochemical proxies as $^{87}Sr/^{86}Sr$ ratios and elemental concentration measurements to understand how signals from individual mobility and/or variable drinking water sources may interfere with the signal from climate variability. For every tooth, we plan to obtain at least 100 individual measurements of $\delta^{18}O$ along the growth axis using Sensitive High-Resolution Ion Microprobe (SHRIMP), allowing reconstruction of climate fluctuations with bi-weekly resolution. The resolution of other proxies will be lower (bi-monthly) due to constraints of the method used, Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA ICP MS), but still enough to detect the patterns of seasonality.

In a relatively large sample of human dental remains from Northern Mesopotamia and Iran, comprised of c. 200 individuals, we will look for patterns of seasonality and temporal trends in climate, using stratigraphical information and radiocarbon datings combined across all the investigated sites to produce long-term chronological reconstruction of direct impact of climate to human societies. On the level of individual archaeological sites we will investigate if observed seasonal signals and local short term trends are correlated with the occurrence of developmental enamel defects and where possible also dentine defects on a macroscopic and a microstructural level as a proxy for developmental stress.

We will focus on two periods that are widely considered as affected by prolonged droughts, i.e. the transition from the Early to Middle Bronze Age (c. 2200-2000 BCE) and the transition from the Late Bronze Age to the Iron Age (c. 1200-800 BCE). By comparing two regions with different ecology, i.e. the relatively humid dry farming zone of Northern Mesopotamia and the Iranian Central Plateau with lower precipitation and farming usually based on small-scale irrigation in the alluvial fans, we will be able to differentiate between regional and global trends in climatic conditions. We could also assess the extent to which people are affected directly on an individual and a community basis with respect to growth and development. Patterns of effects would amalgamate to adaptive behavioural shifts finally responsible for societal change. The ultimate effect of the project may be a powerful tool enhancing our ability to identify impact of short-term climate fluctuations on past human populations.