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ITALIAN STUDY
ABSTRACTS

AN OVERVIEW ON SOIL EROSION IN THE BASILICATA REGION: RELATIONSHIPS BETWEEN GEOMORPHOLOGY, PEDOLOGY AND CLIMATIC TRENDS

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ABSTRACT: The Basilicata region is characterized by a very heterogeneous geomorphological setting, landforms and climate sub-zones. This main intrinsic peculiarity determines a strong *cause-effect* correlation on the influence of the soil erosion process, since it is an erosion-prone site.

The strict environmental relationships - evaluated through the analyses developed – have highlighted the following resulting framework: soil erosion in the Basilicata region is a land degradation form strongly influenced by three environmental factors, such as *geomorphological processes*, *pedogenesis* and trend of *climatic changes.*

The study has been developed through a huge literature search and specific GIS-based analyses, carried out through the following methodological approaches:

i. USPED method applications at a regional scale;
ii. *soil erosion incidence assessments* at a regional and municipal scale;
iii. *soil loss assessment* in relation to different croplands (*on-site* impacts assessment) at a regional scale;
iv. *data crossing survey* at a global scale between the soil erosion model's development's site and the climate zones characterized by relevant climate change from 1926 to 2025.

As far as the climate focus, in order to build the global and then regional climate scenarios, the Köppen-Geiger's (1926-2025) world maps of climate classification has been used by analyzing the most significant climate shifts. Such data crossing survey brought out a relevant global and regional climate change dating back to 1926 until nowadays and also with future forecasts till 2025.

Then, considered the agricultural vocation of the region, this environmental framework has been extended to the economic and agrarian context in relation to three typical regional croplands, such as *cereals* (arable cereals land), *vineyards*, *olive-growing lands,* affected by productivity loss caused by soil erosion from 1980 to 2013.

For this purpose, Dimotta et al. (2016) have proposed an empirical *on-site economic impacts assessment*: *Potential Economic Soil Loss Assessment Method (PESLAM)* aimed at assessing two specific parameters related to the soil loss by erosion, such as the *Potential Economic Loss* and the *Economic Erosion Value*.

About the pedological characterization of the Basilicata's soils - put in strict relation with the eroded arable lands - has showed the soil types more affected by erosive phenomenon, as shown in the analysis carried out by Dimotta et al. (2017).

Thus, the resulting framework has allowed to give significant responses about *how* and *how much geomorphology*, *pedology* and *climatology* are and/or could be related to each other on soil erosion process occurred in the region.

Keywords: *applied geomorphology, pedology, climate changes, agrarian economy, soil loss, on/off-site impacts, southern Italy, productivity trend.*

References (DOI):

1 Dimotta, A., Cozzi, M., Romano, S., Lazzari, M. (2016) Soil Loss, Productivity and Cropland Values GIS-Based Analysis and Trends in the Basilicata Region (Southern Italy) from 1980 to 2013. https://doi.org/10.1007/978-3-319-42089-9_3

2. Dimotta A., Lazzari M., Cozzi M., Romano S., (2017) Soil Erosion Modelling on Arable Lands and Soil Types in Basilicata, Southern Italy. https://doi.org/10.1007/978-3-319-62404-4_5

POLLEN EVIDENCE OF VEGETATION CHANGES AND LAND USE IN CALABRIA (ITALY) DURING PREHISTORY

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Archeological surveys of the last years have witnessed a diffuse human presence in the Tropea Promontory during prehistoric times (Pacciarelli, 2004, 2011; Lo Torto et al., 2011; Jung et al., 2015). In order to better define the impact that humans exerted on this territory during Prehistory, palynological investigations were realized with the main aim of distinguishing the natural and anthropogenic forcing in the evolution of a key region for the Italian Prehistory.

A sediment core was drilled at 555 m a.s.l. on top of the Tropea Promontory, in the Passo Murato locality, where Lo Torto et al. (2011) highlighted the occurrence of buried layers with Eneolithic pottery. The core intercepted one meter of peat covering the pre-Quaternary substratum. Pollen analysis was undertaken on 21 peat samples collected from the peat interval each 5 cm, from 110 to 235 m depth. Almost all analyzed samples resulted rich in well preserved pollen grains and only 4 samples resulted poor; 74 taxa were recognized.

In the basal part of the diagram (Eneolithic), high amounts of microcharcoals, recorded in concomitance with the lowering of arboreal pollen percentages, attest to the use of anthropogenic fires to open the landscape for agricultural practices (cereals) and animal husbandry, which is well testified by the high amounts of fungal spores, indicative of pasturage (Cugny et al., 2010; Ejarque et al., 2011). Starting from 165 cm depth, a decrease in the fire practice is coupled with the recovery of the forest cover and an increase in the marsh plants. These vegetation changes could indicate both a contraction of the marsh and a partial abandonment of the area. Some cereal crops were still present and a peak of *Trifolium* opens up interesting hypothesis on the occurrence of forage crops (Miras et al., 2018). Another important change is recorded from 130 cm depth, when *Alnus* markedly

increases in concurrence with the decrease in Cyperaceae. These results could indicate a further contraction and final closure of the marsh, which led to the rapid development of an alder forest on the wet soils. Evidence of abandonment is clearly recorded in the last levels even if the topmost sample seems to suggest a possible recolonization, with a slight forest decline and cereal increase.

The reconstructed history of vegetation and land use changes on the Tropea Promontory certainly needs further investigation especially concerning their connection to the presence of prehistoric communities. The detailed dating of the core, which is in progress, will allow such connections to be established. With this perspective, the Passo Murato core represents an important sedimentary archive that enriches the knowledge of an important territory widely exploited by prehistoric human communities.

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LAND DEGRADATION
IN THE BADLAND LANDSCAPE OF ALIANO (MATERA, SOUTHERN ITALY)

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ABSTRACT: The badland landscape is highly susceptible to past and actual climate changes. If the past morpho-evolution of the landscape is only indirectly inferable, changes caused by the present climate and human impacts can be studied in detail.
In this study we analyze the topographic changes in a little badlands basin in the Aliano countryside located in the central part of the Fossa Bradanica where the Plio-Pleistocene yellow clayey sand formation outcrops. The badland features develop on this bedrock also as consequence of the climate of the region that is characterized by warm dry summers and temperate wet winters with a mean annual temperature of about 17°C.
We surveyed some characteristic cone shaped landforms on the dissected hillslopes, known as Biancane, by the Terrestrial Laser Scanner (TLS) technology that allow us to make a high resolution survey with a great measurement accuracy, because we want to identify changes that occurred during a ten-year time interval. In fact. the first TLS survey dated back to March 2006 while the last is of May 2016.
We detected the topographic changes comparing 3D models of the TLS point clouds acquired during the two surveys. The point clouds were georeferenced by means of GPS survey of some well recognizable points in order to make the superimposition easy. The vegetation spotted in the point cloud was deleted before the comparison: using image classification based on multi -scale dimensionality criterion (Brodu & Lague, 2012), we distinguish the bedrock from the vegetation to clean up the point cloud. Then, the date processing continues with the two 3-D models superimposed in order to detect the erosion and deposition areas along the Biancane sides. We used M3C2 (Lague et al. 20[3) algorithm

of Cloud Compare that performs a direct comparison on the point clouds also taking into account the accuracy of measurements. The total topographic changes in the 10-year period ranges between -0.26 m and 0.13 m, where negative values represent erosion and positive values represent deposition, because the comparison is carried out by subtracting the 2016-point cloud elevation from the 2006 model. The highest erosion rate is on the larger Biancane in the more elevated portion of the hillslope, where the erosion affects the whole sides with a rate that decreases from the top to the bottom. On the other hand, we observe that on the smallest Biancane, lying in the less elevated part of the hillslope, there is deposition at the bottom due to the lower relief energy and slope.

Keywords: *badlands, erosion rates, modeling, Fossa Bradanica*

ARCHAEOLOGICAL SURVEY DATA FOR ASSESSMENT OF PAST LAND USE

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Data on human activity has largely been obtained through traditional archaeological excavation and extensive regional survey. To date, excavations carried out at Monte Serico (Ciriello *et al.*), Vagnari (Small; Prowse; Carroll), and San Felice (McCallum, vanderLeest, *et al.*), alongside regional surveys undertaken on both sides of the Basentello River since the 1960s (Vinson; Small; McCallum and Hyatt), allow for some degree of informed speculation about the region's settlement history, particularly since the Iron Age, and the types of settlements during these periods. The most recent of these surveys, directed by the author, will form the basis of most of the subsequent discussion. This pedestrian survey, part of the Basentello Valley Archaeological Research Project, or 'BVARP', was conducted in the summers of 2012 through 2015, and the fall of 2013.

The first part of the survey component is an extensive regional survey. Extensive survey has been chosen in order to cover a substantial territory and therefore generate a relatively large and robust sample size that can be used to examine regional issues diachronically. n so doing, the team has eschewed artifact-centered methodologies. The present research is aimed at identifying settlements, settlement densities and hierarchies, site catchments, and, where possible, differential craft and agricultural production. Particular attention is being paid to continuity from the pre-Roman to the Roman period in order to address potential cultural disruption related to the Roman conquest, the Hannibalic War, the Social Wars, and

colonization. In future seasons will include a limited program of intensive survey of previously identified scatters.

Within the survey territory, which covers approximately 190 square kilometers, the aim is for total coverage, although this will not be entirely possible due to the presence of some large structures and a few densely wooded areas, such as the eastern slopes of the massif on which stands the town of Genzano di Lucania. The goal is to cover all types of terrain during field walking, from valley bottoms to level plateaux and the steep sides of hills and ravines, and to survey all fields. Where there is some degree of surface visibility, areas will be covered that are not regularly subject to plowing and that might be covered with vegetation.

For the moment, four categories of evidence are focus of our attention during the analysis of our preliminary results. They are as follows:

1. Artifact densities/Change in densities between periods; Densities are a proxy for understanding demographic change over time.
2. Total area of scatters/number of collection units per period; This will provide information about possible population size at sites or the greater the level of consumption.
3. The average and range of areas of scatters per period; This is important in creating a regional site hierarchy.
4. The range (functional and chronological) of artifactual material present within each scatter. This is a potential indicator of site function and may permit the assignment of function to differently sized sites during specific periods.

Keywords: *Archaeological survey, land use determination, Iron Age, site size and function*

APPLICATION OF THE NEW MORPHOLOGICAL DYNAMICS INDEX (MDI) TO ASSESS SPATIAL AND TEMPORAL CHANNEL EVOLUTION OF THE BASENTO RIVER (SOUTHERN ITALY)

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Morphological Dynamics Index (MDI) classifies the degree of channel dynamics related to progressive changes over a relatively long-time scale and helps to implement future management strategies that consider also hazards related to fluvial processes and channel dynamics. The National Institute for Environmental Protection and research has promoted a methodology named IDRAIM (Rinaldi et al. 2016) for hydro-morphological analysis of streams that pursues an integrated approach in line with the EU Water Framework Directive (WFD, 2006/60/EC), and the EU Floods Directive (2007/60/EC). In this study we present the application of the Morphological Dynamics Index (MDI) protocol, which is part of IDRAIM, to determine the assessment of morphological dynamics of the Basento river terminal sector. The main river channel was divided into 16 river reaches, of homogeneous geological and morphological characteristics. For each river reach "degree of confinement" and "confinement index" was defined, to evaluate river later confinement. The application of 10 other indicators was made for all the reaches defined. The results showed that 56 % of the analyzed reaches have a very high MD Index, 25% have high morphological dynamics, while only 19 % have the characteristics of moderate morphological dynamics. The assessment of these results with the spatial temporal channel changes evolution of the last 150 years, has demonstrated that, reaches that shown a very high and high MD Index, are the same that from 1873 to today had changed their morphological characteristics, in some case also in a very significant way. The main causes that lead these changes are linked to i) human pressure with extraction of fluvial inert and artificial elements (hydraulic infrastructures like dam, expansion basin, and channel adjustments; ii) high magnitude flood events (e.g. March 2011 and December 2013), that even if they did not change morphological pattern, they

determined important morphological variations also in the areas immediately adjacent to the river, which are mostly occupied by agricultural fields and various industrial activities.

Keywords: *channel evolution, hydro-morphological modeling, management strategies,*

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LATE PLEISTOCENE AND HOLOCENE PALEOENVIRONMENTAL CHANGES ND HUMAN IMPACT IN THE ARCAEOLOGICAL SITE OF "PIANI DELLA CORONA", SW CALABRIA, ITALY: A MULTIDISCIPLINARY STUDY

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A multidisciplinary study was carried out on a pedostratigraphic succession excavated in the archaeological site of "Piani della Corona", located on a marine terrace in the surroundings of Palmi city (SW Calabria, southern Italy). An integrated archaeostratigraphic, pedological, anthracological, tephrostratigraphic, isotopic and geochronological approach was applied to reconstruct the major late Quaternary paleonvironmental changes. The upper stratigraphy consists of soil horizons spanning from the middle to the late Holocene, which include late Neolithic to late early Bronze age settlements, lithic and ceramic artefacts, overlain by arable layers of undetermined age. The lower part of the stratigraphic succession shows no archaeological finds, but its bottom dates to the late Pleistocene (radiocarbon age of 27,650 ± 250 a BP). This chronology is consistent with the chemical composition of volcanic glass fragments (vesiculated micropumices) identified using SEM-EDS, which suggests a provenance from late Pleistocene-Holocene eruptions of the Aeolian Islands. Paleoenvironmental changes were reconstructed along the pedostratigraphic succession.

Pedological data evidenced late Pleistocene cold-humid conditions indicated by more abundant short-range order minerals (SROM) probably during an interstadial predating the LGM, as SROM neogenesis is favored by the weathering of volcanic material under prolonged moisture conditions. The late Pleistocene to early Holocene climate amelioration until the Neolithic climatic optimum, characterized by an increase of humidity and temperatures, is evidenced by the presence of clay coatings, coupled with dominance of phyllosilicate clay minerals over SROM, as their formation is favored by warm-humid conditions and seasonal contrast, higher during the climatic optimum. The upper part of the succession records a return to humid conditions, indicated by more abundant SROM and disappearance of clay coatings above the Bronze age paleosurface. The latter and the Neolithic soils are widely affected by soil truncation and anthropic influence (pole holes, cisterns, ditches, plough furrows). Typical soil features related to tillage were also observed at the microscale. Soil charcoal analysis evidenced the dominance of herbaceous taxa during the late Pleistocene, followed by oak forest that persisted during the climatic optimum and after the late Bronze age, suggesting a relatively limited spatial extension of human impact. Carbon isotopic ratios showed a C3-dominated plant community, on the whole typical of cool and wet climates.

Keywords: *pedostratigraphy, archaeostratigraphy, paleoenvrionments, paleosurface, paleoclimate*

WHAT CAN SOILS TELL US ABOUT HOLOCENE PALEOCLIMATE, LAND USE CHANGES AND LANDSCAPE DYNAMICS? AN OVERVIEW FROM CENTRAL AND SOUTHERN ITALY

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A number of papers investigated paleoclimatic and paleoenvironmental changes in Mediterranean sites using traditional continental and marine proxies such as sedimentary successions, fossils, stable isotopes, pollens, plant macroremains, dendrochronology, archaeological findings and historical documents. Paleosols are also used as paleoclimatic archives, but most of the scientific literature in the Mediterranean area is focused on pre-Holocene times.

Here, an overview on the response of soils and paleosols from different contexts of central and southern Italy to Holocene paleoclimate, land use changes and geomorphic dynamics is proposed, mainly based on published papers. An emphasis is also given to different methods and ancillary techniques that have been applied to interpret the pedostratigraphic record, trying to disentangle the role of natural versus anthropogenic factors on paleoenvironmental changes.

A number of soils/paleosols from the Central Apennines to the volcanic areas of Campania and the peri-volcanic Calabria region showed a varying volcanic ash input (often hidden as micrometric cryptotephra material) to late Pleistocene and Holocene pedogenesis, which made them more fertile. This material contributed to a different degree of development of andic properties, related to the presence of short-range order minerals (allophane and imogolite components) derived from the weathering of volcanic glass. These features, often coupled with an increase in iron oxyhydroxide segregation, highlight a clear post-glacial climate amelioration with a moisture increase especially during the Holocene climatic optimum and sometimes also during the late Holocene. At some sites, the coexistence of allophanic materials with neoformed phyllosilicate clay minerals during the late-early to middle Holocene, points to a certain seasonal contrast in moisture availability likely

controlled by a temperature increase. These paleoclimatic conditions are supported by the concurrent presence of clay coatings in a number of coeval soil profiles (including karst cave fillings and Neolithic archaeological settlements), developed both on volcanic and non-volcanic parent materials. These illuvial clay pedofeatures are typical of the middle Holocene (and of past Quaternary interglacials), but in places were identified to a minor extent in soil profiles of Roman age from coastal peri-Tyrrhenian and mountainous inland sites of Calabria. At some of these sites, soil charcoal data evidence a paleovegetation dominated by deciduous oak forest during the early to middle Holocene, also consistent with abundant humus accumulation in the paleosols. A sharp environmental change after such a major phase of geomorphological stability prone to vegetation and soil development, is recorded around 5 to 3 ka BP in many sites of southern Italy. The paleosols close to this time range are often truncated, affected by colluvial processes and/or buried by younger slope or alluvial deposits (and associated soils) and may include pedorelicts, coarse debris and stone lines, indicating stages of landscape instability with increased erosion/sedimentation processes. In the Vesuvius area, stable isotopes in pedogenic carbonates testify to a drying episode, probably induced by a well-known explosive eruption of the Vesuvius volcano. More widely, this important paleoenvironmental shift can be interpreted as a consequence of one or more aridity phases, possibly superimposed (or alternatively controlled) by increased anthropogenic activities during and after the Bronze age. Forest clearance and a drastic transformation of the vegetation cover from oak woodland to pine forest is clearly documented by soil charcoal data in some inland mountain sites, coupled with agricultural practices which increased over historical times also in other sites. Traces of ploughing and crops are widely recorded at the macro- and microscale in late Holocene soil profiles.

Recent erosion during about the last 50-60 years as a response to severe deforestation, agricultural exploitation/abandonment and land degradation is documented in mountain grassland soils of Calabria (as well as along lower hillslopes in SE Sardinia), often used for grazing, by anthropogenic radionuclide tracers (^{137}Cs and $^{239+240}Pu$) derived from nuclear weapon tests. In places, an ongoing soil recovery can be observed even on steep upland landforms, where reforestation policies were carried out during the late 1950s'.

Keywords: *paleosols, climate change, paleoclimate, land use, landscape dynamics, forest clearance*

PAST LANDSCAPE DYNAMICS: ROLE OF CLIMATE AND LAND USE IN LANDSCAPE DETERIORATION

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Abstract

The marine marls of the hill country straddling the Puglia and Basilicata border in southern Italy (the Mezzogiorno), are extremely sensitive to the impact of climate and land use. Prior to the Middle Holocene, climate was the primary driver of landscape dynamics in the region. However, after ~ 7,300 cal. B.P. land use played an increasing role in surficial processes. Today the relative effect of people and climate upon the landscape can be observed and modeled. However, the most important factors affecting erosion processes can only be determined through longer term observation and modeling of the roles of climate and land use in landscape dynamics. Integration of the Bryson and Bryson mesoscale climate model (MCM), and relationships between effective precipitation and sediment yield developed in the American Middle West by Langbein and Schumm, have been correlated to currently available alluvial histories near the southern coast of the Mezzogiorno. This has established correspondences between past effective precipitation, vegetation cover, land use and erosion. Continued refinement of the paleoclimate input data with an increasingly robust regional alluvial history, and with GSI conversion of archaeological surveys into spatial distributions of human distributions and land use will produce more accurate correlations. The model indicates that cycles of erosion are the result of a combination of a period of prolonged spring drought during the last 6,000 years, and triggered by cycles of summer

rainfall. It also indicates that an erosional episode between 7,000 and 6,700 cal. B.P. was the result of forest clearance, and that the magnification of drought episodes since the beginning of the Iron Age 3,000 years ago is the result of intensified land use that corresponded with cycles of increased summer rainfall.

Keywords: *Mezzogiorno, erosion cycles, paleoclimate, land use, mesoscale climate model, intensified summer rainfall*

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Wigand, P. E., M. McCallum. (March 2017). The Varying Impact of Land Use and Climate in Holocene Landscape Dynamics in the Mezzogiorno. Athens Journal of Mediterranean Studies 3(2).

SEDIMENT MOBIITY AND CONNECTIVITY IN THE CATCHMENT: A NEW MAPPING APPROACH

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Abstract: Sediment connectivity is an important element to define channel dynamics in a catchment. Sediment paths are very important to better understand erosion, transport and deposition processes. In fluvial basin analysis, connectivity is a fundamental geomorphic aspect to estimate the sediment movement within the catchment. Nevertheless, a univocal definition of connectivity has not yet been accepted by the research community at large. The present study explores sediment connectivity through a new approach, aiming to integrate functional and structural components. The objective is the production of a sediment connectivity map, directly applicable to monitoring and management activities. Our approach uses a model-based methodology which derives sediment connectivity from gradient-based flow accumulation of sediment mobility, which is in turn defined as a simple function of rainfall, soil type and land use. The method has been applied to the Vernazza basin (eastern Liguria, Italy), producing a sediment connectivity map which shows good performance in predicting the positions of actual mass-waste deposits detected on the ground after the October 25th flood event. The method could be also applied to large-scale applications, e.g. utilizing open global data sets

Keywords: *sediment mobility, sediment connectivity, connectivity mapping*

EASTERN MEDITERRANEAN STUDY ABSTRACTS

ANALYSIS OF DROUGHT CONDITION IN SOUTHEAST OF IRAN

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ABSTRACT: In Iran as a semi-arid and arid region of the world, there are vast expanses of ephemeral lakes and intermittent playas, which are endangered by drought, and even fresh water lakes in the mountains, which are normally unthreatened, have, in recent years, experienced drought due to high rates of evapotranspiration. In this research, the current drought conditions were investigated by calculating standardized precipitation evapotranspiration index (SPEI) in Lake Jazmourian as the representative of Southeast of Iran by using observation data during last century. The results showed that the evaporation intensity has increased during last century in this region. We can conclude that the drought intensity in both warm and cold seasons throughout the year is high. Based on SPEI index in Lake Jazmourian wetland during Jan 1950-2016 there are three intensive drought stages by SPEI<-2 include 1969,1971,2011, 2012,2013, and 2016 among most of the months. The relationship between the drought intensity and sea surface temperature (SST) is significant.

Keywords: *climate modeling, climate changes, drought, Jazmourian.*

IDENTIFYING AND PRIORITIZING THE FACTORS AFFECTING THE DRYING OF LAKE URMIA UTILIZING INTEGRATED FUZZY DEMATEL AND ANALYTIC NETWORK PROCESS (F.D.ANP)

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Abstract: The drying of Lake Urmia has irreversible effects on the environment of the area. According to the criticality of the issue, in this study we identify the affective factor(s) responsible for the drying of Lake Urmia, then we propose a conceptual model with network structure. Due to the side by side dependency of the factors in the conceptual model, to assess the value of affectivity and impressibility, to identify the relative importance coefficients, and to prioritize the factors, we utilize the integrated DEMATEL and fuzzy analytic network process. The results indicate “management aspect” has the highest affectivity and relative importance coefficient in level of main criteria. Further, “absence of preparation and updating a strategic plan to preserve the lake within last years” placed in the first rank in terms of intensity of affectivity, and “lack of attention toward environment, but tendency toward short-term goals by managers” holds the maximum relative importance coefficient. According to the results, it seems necessary that the managers change their attitude from sheer attention to the economic interests to preservation of the environment.

Keywords: *disaster, environment, F.D.ANP, management, MCDM*

HISTORIC LANDSCAPE CHANGES IN JORDAN: DRIVEN BY GLOBAL CLIMATIC ANOMALIES?

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ABSTRACT: Reconstructions of past landscape changes often employ models calculating annual erosion rates based on the size of sediment bodies, assuming grain-by-grain transport of sediments and linear and constant processes of deposition. Then it is often attempted to connect them to past land use and climate by correlations with demographic estimates and reconstructions of past precipitation averages. However, such approaches could be based on unsuited indicators and be doomed to miss the true story. This can be illustrated with a valley fill near the site of Abila of the Decapolis in northern Jordan, that was discontinuously deposited by slumping and earth flows. The greatest part of the sediments apparently accumulated during the 6th century AD/CE. Due to a dominance of smectites, the Red Mediterranean Soils in this area shrink and form cracks during the dry period. Because of the cracks and underlying limestone karst, they can swallow strong rains without erosion risk. However, when water-saturated, these soils expand and can start creeping. Soil-covered geoarchaeological features like small water channels on formerly cleared rocks suggest that soils moved a few cm upslope. Buried grave terraces illustrate that soil creep can create new level surfaces, sealing cavities but not completely filling them. Soil creep on the cemeteries coincided with periods of slumping and earth flows in the valley, which seems likely as instable rocks might collapse under heavy rains and the weight of a creeping soil. That land use played a minor role for these events is suggested by surveys of archaeological material on the fields suggesting that the periods of most intense land use coincided with virtually no sediment deposition. Analogies with modern rainfalls, including record levels of precipitation during the winter 1991/1992, indicate that levels of soil moisture triggering soil creep and slumping have not been reached during times of modern rainfall monitoring. This suggests that deluges of unknown intensity occurred during Late Antiquity. A 'year without sun' or 'Mystery Cloud' which the historian Procopius observed in the year 536 AD might resemble the global impact of a volcanic eruption, leading to climatic

anomalies that manifested in the deposition of the valley fil in northern Jordan. Such events could have played a much more important role for various past landscape changes than previously thought. If similar scenarios repeat under climatic irregularities induced by global warming, rather pessimistic perspectives are indicated as there is little that could be done to mitigate or control them.

Keywords: *climate change*, *landscape change, sediment grain size, erosion rates, past erosion analogues*

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THE EFFECT OF LATE QUATERNARY CLIMATE CHANGE ON DOMESTICATION OF CROPS

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Abstract: Climate has been, and is becoming, a major factor to change of the landscapes. Dry and cold climatic conditions during the Younger Dryas caused human populations to move to areas that had a warmer and more humid climate. When many European regions were affected by the cold climate of Younger Dryas there was a better climate in Fertile Crescent and Levant. In the early Holocene climatic conditions were even better than during the Younger Dryas, at this time sedentary small groups in the more favorable areas of the Fertile Crescent gathered, and early agriculture arose. Rapid climate changes have led to increased cereals adaptation, and it was even a significant factor in their domestication during the beginning of the Neolithic. Short and thick stems, circularization of grains, increase the amount of protein in the seeds, increase in grain size and other morphological and genetic changes have been due to the sudden and rapid changes in late Quaternary climate, especially during the early Holocene.

Keywords: *Holocene climate, Fertile Crescent, domestication, cereals, Neolithic.*

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MODELING THE IMPACT OF PAST EROSION EPISODES IN THE URMIA BASIN UPON LAKE CHEMISTRY: PROXIES FOR CURRENT AND FUTURE LANDSCAPE DYNAMICS AND LAKE HEALTH

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Abstract: If the trend toward warmer global temperatures continues, reduced vegetation cover resulting from drier conditions, will increase the susceptibility of the Lake Urmia Basin in northwestern Iran to increased erosion rates. Sediments carried into Lake Urmia, will provide fresh, unconsolidated materials, which are easily eroded by wind during lake bottom-exposing, summer drought. Eroded sediments will also accelerate filling and shallowing of the lake, and increase rates of evaporation due to warmer lake temperatures. In addition, seasonal wetting and drying of lake bottom sediments will disintegrate any clay or salt crusts that have may have formed, making them more susceptible to deflation. With global warming the rate of warm season evaporation will increase, as will the length of the drying season, and the duration of annual exposure of lake-bottom sediments to aeolian erosion, so even larger areas of lake bottom will become exposed to deflation.

The model used to reveal past climate-based erosion cycles in southern Italy can be used to reconstruct past erosion cycles in the Lake Urmia Basin. Applied to the lacustrine record in Lake Urmia, a high degree of correlation is revealed between increased spring and summer rainfall, increased erosion and changes in lake chemistry. The model can also be calibrated to account for human activity during the Holocene. Applied to future scenarios of global warming this model can then be used to predict rates of erosion during the coming century, and their impact in the Lake Urmia Basin.

Given the assumption that each degree centigrade increase in regional temperature results in a ten percent decrease in effective precipitation. The two-degree increase in global temperature projected during the next century should result in a 20% decrease in effective precipitation in the Lake Urmia Basin. This decrease will significantly decrease vegetation cover, increase erosion rates, and result in the deposition of fresh sediment on the floor of Lake Urmia. Increasing sediment deflation, and downwind dust storms will cause dramatic increases in human respiratory illness and cancer clusters during the coming decades.

Keywords: *Lake Urmia, erosion cycle, global climate change, lake chemistry; aeolian deflation; MCM sediment yield model*

RIPARIAN HABITAT MITIGATION AND RESTORATION WORKSHOP ABSTRACTS

PROPER FUNCTIONING CONDITION ASSESSMENT FOR INTEGRATED RIPARIAN MANAGEMENT

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Short version

Riparian functions enable multiple landowners to cooperate for enhancing forage, fish and wildlife habitat, water storage and quality, aesthetics, land value, and reduced risk. Functions depend on vegetation that slows water, allowing sediment to become floodplains and soil -- the sponge that holds water to grow the water-loving vegetation that binds streambanks. Riparian PFC assessment begins with an interdisciplinary team considering attributes and processes to understand and describe potential or altered potential. They evaluate condition by documenting hydrology, vegetation and geomorphology to understand functions and risks. This informs integrated riparian management, an adaptive process focused on the priority reaches and their needs. Objectives and management enable self-healing for restoration of functions. Monitoring and a focus on riparian vegetation helps identify the need for adjustment in management.

Long version

Riparian areas are the center of many land uses and much management that can have detrimental effects on streams. Stream channel incision impacts upstream and downstream landowners and all those who depend on the stream for water, forage, habitat, or recreation. Riparian functions enable multiple landowners to cooperate for enhancing forage, fish and wildlife habitat, water storage and quality, aesthetics, land value, and reduced risk. These functions depend on vegetation that slows water, allowing sediment to become floodplains and soil -- the sponge that holds water to grow the water-loving vegetation that binds streambanks. Riparian proper functioning condition (PFC) assessment

begins with an interdisciplinary team consisting of a hydrologist, plant ecologist, soil scientist or geomorphologist and fish/wildlife biologist, considering attributes and processes to understand and describe potential or altered potential. Because each watershed or water catchment and each reach of the stream is unique, the Team needs to consider Climate and Hydrology, including weather and precipitation patterns, discharge patterns with extreme events, runoff, infiltration, and base-flow relationships, position of water table, surface-/ground-water interactions, floodplain storage and release, flood modification, stream power, and hydraulic controls.

They evaluate condition by documenting hydrology, vegetation and geomorphology to understand functions and risks. This informs integrated riparian management, an adaptive process focused on the priority reaches and their needs. Objectives and management enable self-healing for restoration of functions. Monitoring and a focus on riparian vegetation helps identify the need for adjustment in management. These are influenced by geology and geomorphology and influence modifications to landform, so they consider bedrock and surficial deposits, valley bottom geometry, watershed properties, bank stability, bed stability, sediment characteristics, floodplain accessibility and extent and channel characteristics, including cross-sectional area, bank-full width, width/depth ratio, pattern, sinuosity, and gradient. Riparian vegetation, including many species that can live in saturated anoxic soil drive much of the processes of formation and recovery along stream systems so the team considers community types and distribution, the wetland indicator status of plant species, their response to disturbance dynamics & succession, recruitment/reproduction, survival, and their root characteristics. Soils are formed through an interaction of all of the above and they in turn provide the substrate and control the growing conditions for vegetation. So the team considers soil type, texture, moisture regime, distribution of aerobic & anaerobic soils, organic matter (which is tremendous in its ability to store water), chemistry, erodibility, and bulk density. A lotic riparian area is considered to be in PFC, or “functioning properly,” when adequate vegetation, landform, or woody material is present to: Dissipate Stream Energy associated with high water-flow, thereby reducing Erosion and improving Water Quality; Capture sediment, and aid Floodplain development; Improve floodwater retention and ground-water recharge; Develop root masses that stabilize streambanks against erosion; and Maintain channel characteristics. To assess PFC, the Interdisciplinary team answers yes or no (occasionally

not applicable) and records notes about their rationale about seventeen items or statements.

Five items address hydrology: 1. Floodplain is inundated in “relatively frequent” events; 2. Beaver dams are stable; 3. Sinuosity, gradient, and width/depth ratio are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region); 4. Riparian area is expanding or has achieved potential extent; and 5. Riparian impairment from the upstream or upland watershed is absent. Collectively these hydrology items address the condition of the riparian area to retain water. “Keeping water on the land longer” is a catch phrase for PFC because water provides the plethora of riparian values and enables the kinds of plant communities that thrive in saturates soils and that have the strong root systems needed to usually survive the shear stress and power of floods.

Seven address vegetation: 6. There is adequate diversity of stabilizing riparian vegetation for recovery/maintenance; 7. There are adequate age classes of stabilizing riparian vegetation for recovery/maintenance; 8. Species present indicate maintenance of riparian soil-moisture characteristics; 9. Stabilizing plant communities capable of withstanding moderately high streamflow events are present along the streambank; 10. Riparian plants exhibit high vigor; 11. An adequate amount of stabilizing riparian vegetative is present to protect banks and dissipate energy during moderately high flows; and 12. Plant communities are an adequate source of woody material for maintenance/recovery. This sequence of vegetation items helps managers know how far along they may be in their management or the area’s risk from lack of proper management. Usually it is vegetation that drives recovery from at-risk or nonfunctional conditions. The vegetation needs the water appropriate to the bioclimatic region and geomorphic setting. By modifying roughness, velocity and shear stress, bank integrity, and erosion/deposition, vegetation facilitates or prevents a series of channel changes that could spiral up or down in a feedback loop leading to restoration or loss of functions, stability and riparian ecosystem services.

Five items address Geomorphology: 13. Floodplain and channel characteristics (i.e., rocks, woody material, vegetation, floodplain size, overflow channels) are adequate to dissipate energy; 14. Point bars are revegetating with stabilizing riparian plants; 15. Stream banks are laterally stable; 16. Stream system is vertically stable (not incising); and 17. Stream is in balance with the water and sediment that is being supplied by the drainage basin (i.e., no excessive erosion or deposition). The shape of the channel and floodplain (where

applicable) greatly influences water velocity and shear stress in critical bed or bank locations. Net bed erosion and incision greatly concentrates stream power, whereas bank erosion can diminish unit stream power and allow aggradation. Streams and rivers self-form in relation to their water and sediment discharges. However, human modifications to the supply of water and/or sediment, or to the condition (size, shape, pattern/gradient, and roughness) of the channel, floodplain, and riparian area can modify the relationships that ensure or re-create balance. Channel incision and resulting instability occurs in a great many human modified riparian areas. This sets in motion a sequence of steps that ultimately leads to self-healing. Yet humans who do not understand these processes or perceive themselves threatened by them often take actions that perpetuate instability or delay (perhaps semi-permanently) the recovery of riparian functions and values.

Collectively these seventeen items and the notes about the rationale for a yes, no, or NA for each one tells a story about that stream reach. The information gained and now in the conversation about that area allows the interdisciplinary team to rate the condition in relation to the unique potential for that reach and the definition of PFC. The relative condition can also be noted on a "thermometer". They can also interpret evidence of change through time as a trend toward better or worse functionality (trend up or down). This evidence may be based on monitoring data (such as old photographs or measurements) or require interpretation of only their observations at the time. The team can also note any understandings they may now have about causes either within the control of the riparian landowners or land managers, or outside of their control.

Locations and functional conditions that are outside of one's control suggest the need to expand the circle of the conversation. By including upstream or downstream landowners or others who may control water flows, roads, engineering, etc. watershed groups sometimes increase their sphere of influence. Often though the on-site landowner/manager has many tools at hand for better riparian management that can be used to increase riparian functionality. In the US, much of the riparian discussion centered at first around forest practices and livestock grazing.

Grazing management is often most needed in dry regions where cattle concentrate their grazing near water where the forage stays greener and more nutritious longer. Recognition of the issue accelerated where fences were used to exclude livestock from certain riparian areas. The fence-line contrast soon became startling. With experimentation, many

alternative strategies for riparian grazing management have been studied and are now being used to improve management across vast landscapes with dispersed or concentrated riparian resources. While no one grazing system is always needed or ideal, the season of use is very important because of differences in upland and riparian growing season. Also, the duration of use is very important because of the impact of repeated grazing on plants that are not fully recovered. Shorter periods of use correspond with longer periods for recovery.

These tools, and the ability of people to use them, have led to dramatic changes that can be seen from space. They have also led to the opportunity for adaptive management as the streams change and become more resilient to disturbance and more resistant to loss of functions. Across many examples with incised channels, gully bank erosion was rapid but gully bank erosion not the issue or the focus. Streambank erosion was often an issue. Streambanks are the part of the bank that is often wetted by normal fluctuation in water flow, usually at least once in a three -year period. The streambanks were allowed to recover as managers focused on riparian vegetation, grazing season and duration, and the length and growing season timing of recovery periods between grazing periods.

The PFC concept is based on the observation that systems need to be functional before they can produce most or optimal aquatic or riparian values, or desired conditions. Assessing PFC is the first step in an "integrated riparian management process." Additional steps include:

2. Identify riparian resource values and complete additional assessments;
3. Prioritize reaches for management, restoration or monitoring actions;
4. Identify issues and establish goals & objectives;
5. Design and implement management and restoration actions;
6. Monitor and analyze effectiveness of actions & update resource condition ratings (PFC);
7. Implement adaptive actions.

Keywords: *riparian management, maintenance, PFC concept*

RIPARIAN MANAGEMENT AND RESTORATION ALTERNATIVES FOR INCISED CHANNELS

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Short abstract

Serial engineering is the bane of "first do no harm." It implies that floodplain development, enabled by the flood memory half-life causes increased damage in future flooding and flood control leads for floodplain development. Many strategies help avoid serial engineering. Meandering channels are stable in pattern, profile and dimension, but necessarily dynamic in location. Restoration is scale dependent and across a continuum from allowing self-healing to assisted restoration with vegetation, wood, rock, expanded floodplain access inside the gully or on the abandoned floodplain (terrace). More sophisticated engineering methods imply greater cost and risk. Of the many strategies for improved riparian grazing management, the most powerful are movement of animals to allow recovery of vegetation. Many wetlands can be restored by using subsurface aquatards and a low gradient, wide vegetated spillway. While many laws motivate wetlands and riparian restoration, the key is that they enable adaptive management as systems change and we learn from experiences. Adaptive management monitoring focuses on objectives and strategies.

Longer version

The first step in riparian management is to do no harm by taking irreversible actions that create lasting consequences or prevent recovery. Unfortunately, we do this in many locations across the globe on a regular basis. Jeff Mount, who wrote the book on California Rivers and Streams, diagramed "The flood memory half-life: The power to forget" that he uses to illustrate people's decline awareness of the threat, risk, and their psychological

distress. He goes on to use this concept in describing the process of serial engineering of rivers and floodplains. Our most fertile land is alluvial floodplains that have been collecting loamy sediments and organic matter for millennia. As people farm these lands, floods are inconvenient because they may delay planting or prevent harvesting. Impacted landowners then go to the channel and use a variety of methods to speed waterflow or lessen flood impact -- clearing and snagging to remove roughness from trees, cutting through meanders, straightening channels, building agricultural levees, and building reservoirs for multi-purposes including flood control. Each of these steps allows more ease of land use and because of the flood memory half-life, it allows people to invest in more floodplain infrastructure – fences, sheds, roads, barns, houses, etc. With more infrastructure, more damage occurs in floods that increase in magnitude as watersheds replace water catchments. Damage is also increased as stable properly functioning riparian areas get replaced by incised and rapidly migrating channels. Eventually the agricultural land uses convert to more developed land uses with sub-divisions, schools, etc. With every turn of the serial engineering cycle, the diminishing awareness of the previous and next flood allows people to put more of their life's investments at risk and then become more determined to do "flood control." People can do increasingly expensive flood control as flood damage increases and as Jeff says, "concrete begets concrete."

Fortunately, there are many ways to avoid serial engineering. We can work together to understand the process and prioritize floodplains for conservation easements. This helps to keep floodplain land uses flood compatible without incurring the burden of public ownership. Of course, that too is an option for nature preserves or flood compatible recreation. Building causeways or adding floodplain culverts allows flood waters to flow across the floodplain under roads instead of concentrating floodwaters and erosive forces under bridges that are too narrow. Moving roads away from streams reduces their tendency to cut off or fill in part of the floodplain and thereby concentrating flood energy

If levees are needed to protect developed areas, set back levees placed well away from the riparian area can allow most riparian functions to continue. This also informs future development that the flood way is going to be flooded in spite of their poor memory. Official floodways where no development is allowed if it will increase the stage of the flood onto neighboring properties are a regulatory means to maintain space for flooding.

Because meandering channels are meant to be stable in form and pattern (meandering), but dynamic in their location (migrating with meanders that swing back and forth across and sweep down valleys), don't block channel movement. Riprap and other bank erosion treatments are a symptom of altered form and function and an indication of a limited view point. These can be removed if landowners own both sides of the channel and understand the greater long-term good that comes from riparian functions. Even bio-serial engineering is not green if it prevents self-healing. Most incised channels must expand their incised width before there is space to re-create space for floodplains and meanders within the incision. Where there is conflict between the market incentives of the landowner and the public values of aquifer recharge, reduced peak flows and prolonged base flows downstream, water quality, riparian habitats, etc. there can be government programs to share the burden and enhance net benefits. Landowners can also be paid for the public benefits of a flood bypass. Whenever the flood bypass is flooded - they get paid; that payment is much less than the cost of flood control to the areas previously developed. Fortunately, many landowners are learning to cherish soil carbon and aquifers. They can also learn to grow flood compatible crops/pastures and to properly graze riparian forage.

When considering stream and watershed restoration, results can extend across orders of magnitude of time and space. Scale of biophysical processes implies scale in the magnitude of the conversations. Perhaps because of the tremendous values associated with riparian and aquatic ecosystems there have been many experiments and case studies. These have been assembled into volumes for guidance to others. Of course, there is also a great diversity of goals and specific objectives. Form-based approaches tend to get used in areas where channel form is changing and those dynamics threaten property. These approaches tend to emphasize bank stabilization with hard stabilization, rock, wood, and bioengineered structures. Where riparian functions and values motivate a process-based approach, natural self-healing, beavers, temporary beaver-dam analogs, and vegetation assist floodplain reconnection. Bioengineering seems to fall in the middle. It is with vegetation, not rock or concrete, to reduce erosion, and it may create some aesthetic appeal and some marginal riparian vegetation habitat. However, if bioengineering protects a bank from erosion it may prevent the widening of an incision that would otherwise allow floodplain formation and aggradation.

Another approach is to “let the water do the work” with induced meandering that lets and helps the water do the work. Bill Zeedyke and Van Clothier borrow from the insights of others to teach people to use rocks, logs, or vegetation to shift the flow forces against alternating locations along an incised channel, the erosion creates space and begins to form the pattern for a meandering channel with a floodplain. They also emphasize that preventing headcut erosion with Zuni bowls and other structures is also important to prevent the incision in the first place.

In many places where riparian recovery has been enhanced by altered livestock grazing management, willows and other riparian shrubs and trees allowed beavers to build dams. Beaver dams create long-term stability in some settings as they trap sediment and store water that expands riparian vegetation, improves its function, and creates a diversity of fish and wildlife habitats. In other systems, beavers may be a temporary part of the process, or they may cycle in and out of the system by providing structure when needed and moving on when the ponds fill with sediment or the system no longer grows the type of vegetation needed for persistent dams. Because people do not like beavers cutting favorite trees or where there may not be the right landform or hydrology for beavers, beaver dam analogs have been built with woody material. The sticks and logs allow water to pass through the dam, but slow water velocity to encourage some sediment deposition above the beaver dam analog. These deposited sediments can store water and encourage riparian vegetation to enhance riparian functions. Where people want to encourage beavers or influence the location of beaver dams, people sometimes cross the channel with a line of posts. These make dam building easier for beavers and they may choose the posts rather than a culvert or bridge.

Plug and pond wetland restoration replaces an incised channel with a plugged up incision and that puts the water flow back onto the valley flat that was the historic floodplain and was recently a terrace after the incision. This new channel is often encouraged to use a previous channel with a series of minor modification (if needed) to provide a proper gradient, sinuosity, width depth ratio, and riparian vegetation for its long-term stability. The old incision is plugged with material taken from the walls of the gully and the fill material is compacted and raised to an elevation above the historic floodplain. The old channel is thus no longer allowed to be the place in the valley where water flows except in floods that fill the valley. The holes above the plugs fill with groundwater as the water flowing in a channel

with access to the floodplain recharges the aquifer. This aquifer had been drained by channel incision until the gully was plugged. Of course, it is essential to maintain the stability of this restored wetland. The newly watered channel could incise if it is not properly designed or if improper grazing or other management allows it to become at-risk or nonfunctional. Wherever the water re-enters the downstream channel, that drop in elevation is a place where potential energy is converted to kinetic energy and erodible soils must be armored to prevent accelerated erosion and headcutting.

Because wetlands have often been drained in pursuit of farmable land, many wetlands can be restored by filling these drains. Clay that is very slowly permeable is preferred as an underground plug that backs water behind the underground dam. Wherever the surface of the dam or the spillway is designed to be at a very minimal slope, the combined action of vegetation and very broad widths that allow water passage at minimal depth keeps the hydraulic shear stress to a minimum.

In the US, there are many laws that motivate riparian or wetland restoration or may prevent further incision and degradation. This speaks to both the high values of quality habitats, water, and riparian functions and to the bureaucracy that may ensue with getting permits to accomplish projects, even restoration projects. This and requirements for public involvement speak to the need for engagement with the many stakeholders. Consensus building processes can create a shared vision of the goals and objectives. Patient conversations about the intended and unintended consequences reassure people who may not be familiar with the need for or the benefits of keeping water (including floods) on the land longer. Over the course of my career, riparian management has been a major focus of rangeland management, especially on public lands where fish and wildlife habitat are legally important. As I've studied streams and how they work, I have come to realize that riparian functions are even more important on private lands, especially those where the valley gradient is low and the valleys are wide. These are the places where floodplains and the erosion resistance of riparian vegetation are most important. Wetlands are some of the most productive plant communities on earth and they can be harvested sustainably as long as those riparian functions are maintained.

Three times I have worked with a group of others to author a rangeland monitoring handbook. A diagram from the third edition shows a framework for monitoring. Whatever motivates or guides our actions, it is important to focus on priorities. By considering the

potential of individual locations to respond to management, people can write objectives for what they hope to accomplish. These objectives determine what and how to monitor over the long-term. Strategies for management describe how the objectives will be accomplished and these must be monitored to track what was done to achieve the results. The combination of strategy implementation and results in achieving objectives informs us in modification in the ever-progressing cycle of adaptive management.

Keywords: *adaptive management, do no harm, concrete begets concrete*