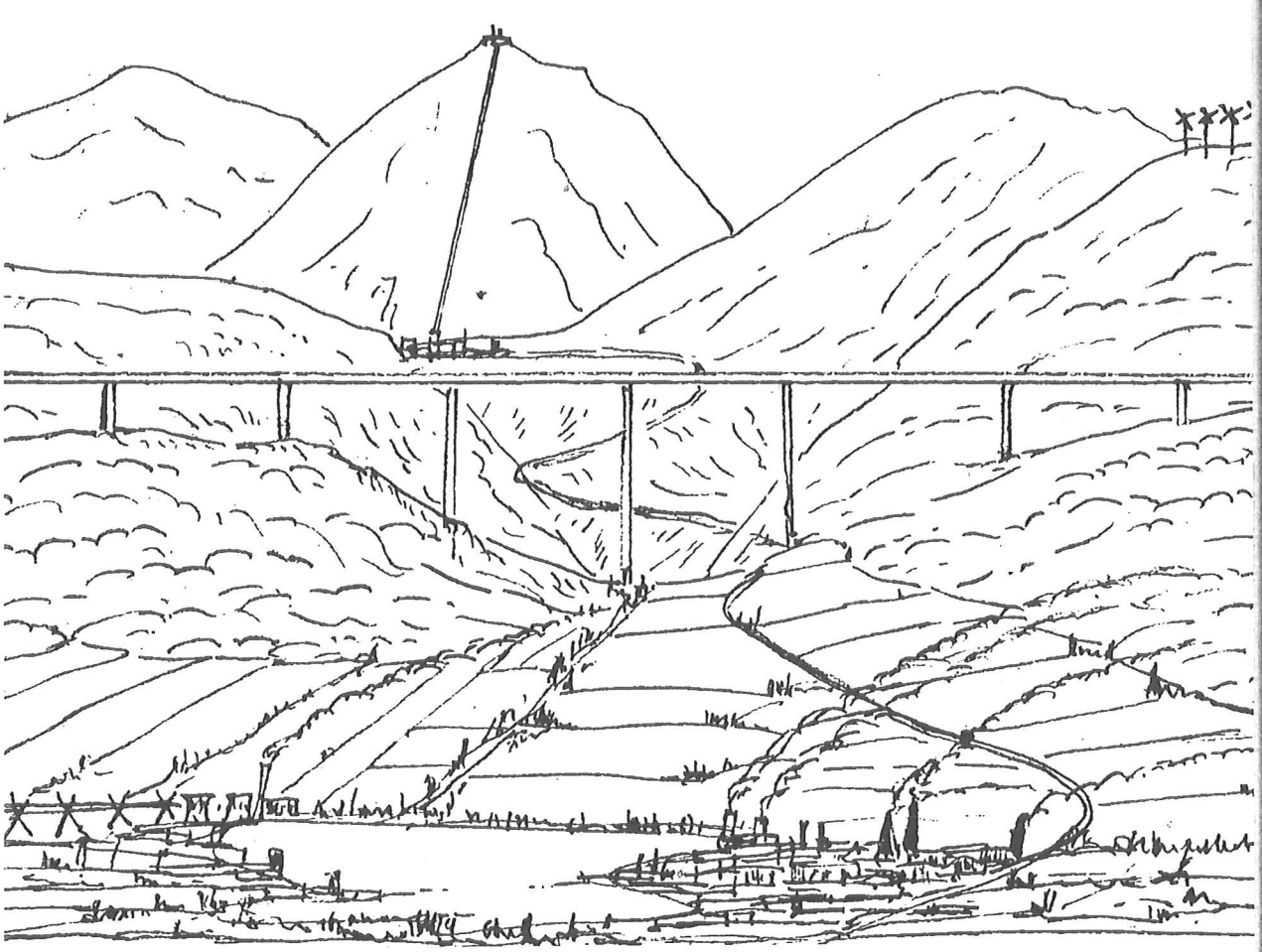
25 years
IALE 2007 World Congress July 8th -12th

25 Years of Landscape Ecology: Scientific Principles in Practice

Proceedings of the 7th IALE World Congress - Part 2



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Climate change consequences for tidal freshwater wetlands at the east and west coast of the Atlantic

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Fresh water in the estuary

Tidal Freshwater Wetlands (TFW) are flooded twice a day and typically are rich in nutrients, have high biomass production and high rates of nutrient turnover. A brackish estuarine zone and a non-tidal riverine system form the boundaries. They occur in the estuarine zone of maximum turbidity and for that reason are rich in sedimentation of clay and are very fertile. TFW occur in coastal estuaries where river discharge is constant on an annual basis and flows are high enough to limit the upstream extent of brackish water, so that no salinity fluctuations occur except for the lower end of the fresh water zone where fresh and brackish tidal waters mix (Barendregt *et al.*, 2006). TFW occur in estuaries of the main rivers of Western Europe, Eastern North-America and Alaska.

A variety of habitats occur in TFW. Sub-tidal habitats (creeks and mud flats) have no vegetation or floating/emergent aquatic beds. Higher in the tidal zone, herb dominated low and high marsh habitats occur and are dominated by species of *Scirpus* and *Phragmites* (Europe) or *Nuphar* and *Zizania* (North-America). Still higher in the intertidal zone, shrub-scrub dominated areas and forested areas occur. Most TFW have mosaics of vegetation types. Biodiversity increases with the elevation and while diversity is typically high in TFW, few species are restricted to this type of wetland and few threatened or endangered plant species have been identified. They are characterized by high biomass production, with values as high as 20 ton/ha/year. At the same time decomposition rates are high, as are turnover rates of nitrogen and other nutrients such as silica. Water quality is mesotrophic to eutrophic in river systems that also have a variety of intense human dominated land-uses. Many TFW are impacted by high nutrient concentrations associated with treated or untreated human waste.

Humans have influenced TFW habitats for a long period. In Europe, for millennia people lived in these areas, mostly to harvest fish and mammals. Around 500 BC agriculture started and by 100 AD the first hydrological structures had been developed to manage water for purposes of improving agriculture. During the last 500 years many areas have been reclaimed for agriculture and in the last century TFW have been impacted by expanded industrial activities. In North-America TFW also have a long history of being impacted by human activities, but more of the original landscapes survives compared to Europe.

Global change in TFW

In TFW, global changes are likely to manifest themselves in three ways: sea level rise, (positive or negative) changes in precipitation and increasing temperature. The consequences will be discussed for the different possibilities.

Sea level rise could result in an up-estuary distribution of brackish water into areas now dominated by TFW, The rate at which this will occur may depend on the geomorphology of each river system. In lowland regions with deltaic plains, such as in NW Europe, sea level rise may not have as much of a negative impact on TFW when space will be available for them to move further upstream. Moreover, the high sedimentation rates (1 cm/year is

possible) will effect a reshaping of the new areas in the estuary. In regions of eastern North-America where the boundary between the coastal plain and the piedmont is characterized by a sharp increase in elevation, real problems occur and many TFW may disappear.

Changes in precipitation can affect TFW in two ways. Higher amounts of precipitation will result in an increasing discharge of the river and the brackish front in the estuary will be pushed in the direction of the sea; resulting in a down-estuary movement of TFW and an increase in their aerial extent. Lower precipitation will result in less river discharge and an up-estuary movement of brackish water; resulting in the replacement of the fresh water portion of rivers or a reduction in its extent. A third scenario could occur in areas where precipitation continues to be high but becomes unpredictable so that the discharge might fluctuate and result in salt intrusion. In these situations TFW are likely to be reduced in extent.

Rising temperatures will effect processes and species distribution. Comparing species distributions along the latitudinal gradient where TFW occur along the east coast of USA or west coast of Europe suggests that changes in vegetation in response to rising temperatures will be minimal. It seems likely that there will be a replacement of some species as southern plants move northward. However, the ecological characteristics of these species will be comparable with the present species and no impact on the ecosystem functions can be foreseen.

The most prominent change in the landscape processes will be performed when salt intrusion occurs into the tidal fresh zone of rivers that have TFW, resulting in a system change from fresh to brackish. Species distribution and the diversity will be affected as plant species characteristic of brackish wetlands move into TFW habitats. The consequences of the change (possibly short-term) will be a decrease in productivity, but more important are the changes in gas emissions from a system that emits methane to one that is biogeochemically driven by processes that occur in brackish wetlands.

Effect of global change on TFW

Based on present climate models, can we predict what changes are likely to occur in some of the areas where TFW occur in North-America and Europe? The set of estuaries in North-west Europe will at the same time be affected by a higher discharge from the river and a downward change of the brackish front, and a sea level rise with an upward change of the brackish front. A preliminary global prediction is a zero effect.

However, the estuaries in South-west Europe might be endangered by either a decrease in precipitation or increase in the timing of precipitation resulting in altering periods of wet and dry conditions. Under this scenario the characteristic landscape ecological processes in TFW might be impacted and replaced by brackish marshes.

On the east coast of North-America comparable processes with South-west Europe might occur, since less precipitation and especially the increase in fluctuations of water levels and storms will result in more intrusion of brackish water. Moreover, these regions will suffer from the increase in sea level and by that in a reduction of the available area for TFW.

Our ability to predict the types of changes that will occur in the tidal fresh zone of river systems that support TFW will increase as the accuracy of global change models increases. In the interim, examination of long-term data sets on patterns of riverine salinity offer the best source of information for examining where changes are likely to occur and the rate at which the changes are likely to happen.

References

Barendregt, A., Whigham D., Meire, P., Baldwin, A. & van Damme, S. (2006) Chapter 6 - Wetlands in the Tidal Freshwater Zone. In: R. Bobbink, B. Beltman, J.T.A. Verhoeven & D.F. Whigham (Eds) *Wetlands: Functioning, Biodiversity Conservation, and Restoration*. Ecological Studies - Volume 191, Springer Verlag, Berlin, pp. 117-148.