Geophysical Research Abstracts
Vol. 17, EGU2015-3011, 2015
EGU General Assembly 2015

Masterplan to safeguard Venice and to restore the lagoon and conterminous areas

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Venice and its lagoon constitute a complex system, well known all over the world for the peculiarity of the town and for the fragility of the lagoon ecosystem with its delicate equilibrium. The whole system has been, and is currently, affected by human activities (industry, agriculture, settlements, tourism) that impact severely the ecosystem. Discharge from the agricultural drainage basin affects particularly the area North of the city of Venice; the central and southern areas, instead, receive important pollutant inputs from the industrial zone of Porto Marghera since the early'50s. Additional sources of pollution are domestic sewage and waste disposal from the urban area, that is visited by more than 10M people every year. As a consequence of the increasing land contamination, significant amounts of contaminants (both organic and inorganic) are accumulated in soils of the borderline, in water and in lagoon sediments, which constitute a potential source of secondary pollution.
Results of surveys carried out in recent years in the whole area show that contaminants concentration increased from the beginning of the industrial activities until the '90s, when Porto Marghera declined. Most of contaminants have concentrations above the background levels. The highest metal levels were found in an area between Porto Marghera and the city of Venice, where both industrial and urban sewage are discharged, provoking environmental and human health hazard.
In order to safeguard the city of Venice, and to restore its lagoon and conterminous areas, a Master Plan of intervention has been developed since the early 2000s. The land currently interested by environmental analysis and/or restoration covers approximately 1350ha; 78% of these (1100ha) proved variously contaminated, with 85% of sites overcoming the National Reference Values. Contamination, besides being diffused, is quite complex, involving the co-existence of several contaminant families (PAH, PCB, dioxin, heavy metals). PAH and metals, in particular, present wide diffusion, both horizontal and vertical (until 5 m below the sea level), with As, Zn, Cd and Hg being the elements more represented in all the soil strata considered.
The lagoon sediments inside industrial channels is higher than the other parts of the lagoon; major contaminants are metals (As, Cd, Hg, Pb) and organic micro-pollutants (PCB, PAH); ammonia and phosphate too are present with conspicuous concentrations, contributing to lagoon eutrophication.
Groundwater contamination is diffused and complex, with As prevailing over Pb and Cr(VI).
The primary objective of the Master Plan was to reduce/eliminate the risk associated to the contamination sources of past activities, and the consequent environmental and human health hazard.
Restoration is still in progress, and concerns different intervention strategies:
• Channel overbank containment to prevent contaminant migration to water;
• Excavation, physical removal and re-distribution of channel sediments (A and B classes);
• Landfilling of heavily contaminated sediments (C class);
• Soil containment to impede contact with people and the environment;
• Restoration of contaminated agricultural land with phytoremediation techniques.
Concerning in particular the last item, restoration has been carried out with native or exotic vegetation (e.g. Fragmites australis, Juncus lacustris, Pterix vittata, Spartina maritima), or cultivated plants (e.g. Heliantus annuus, Zea mays, Brassica napus), with contrasting results.
The exotic fern (Pterix vittata) proved highly effective to accumulate As, consistently with data from literature; Spartina maritima proved more effective than Fragmites australis to uptake metals, while cultivated plants could not survive to high heavy metal concentrations.
At some sites, soil has been stored, selected and finally (the most contaminated part) delivered to landfill, while groundwater was remediated by bioremediation techniques.