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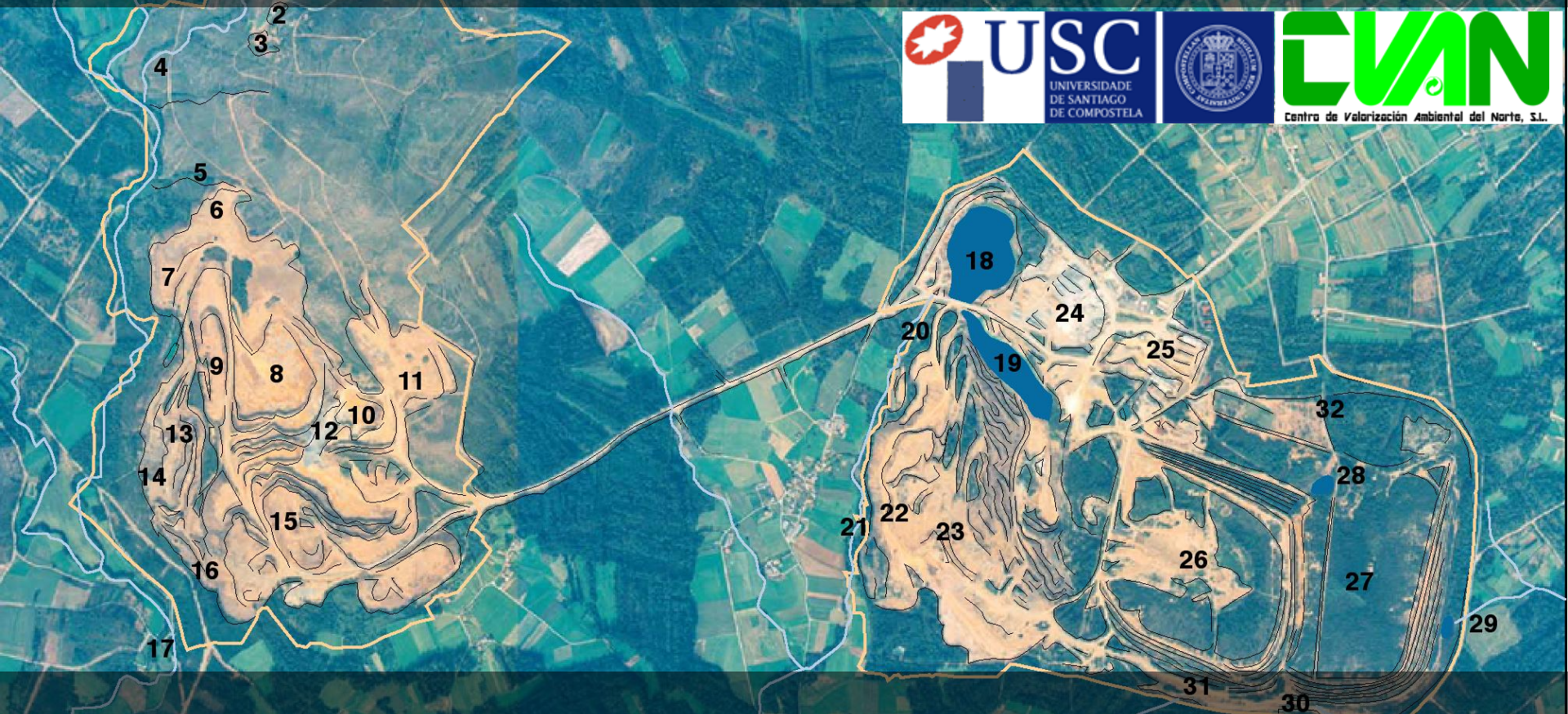
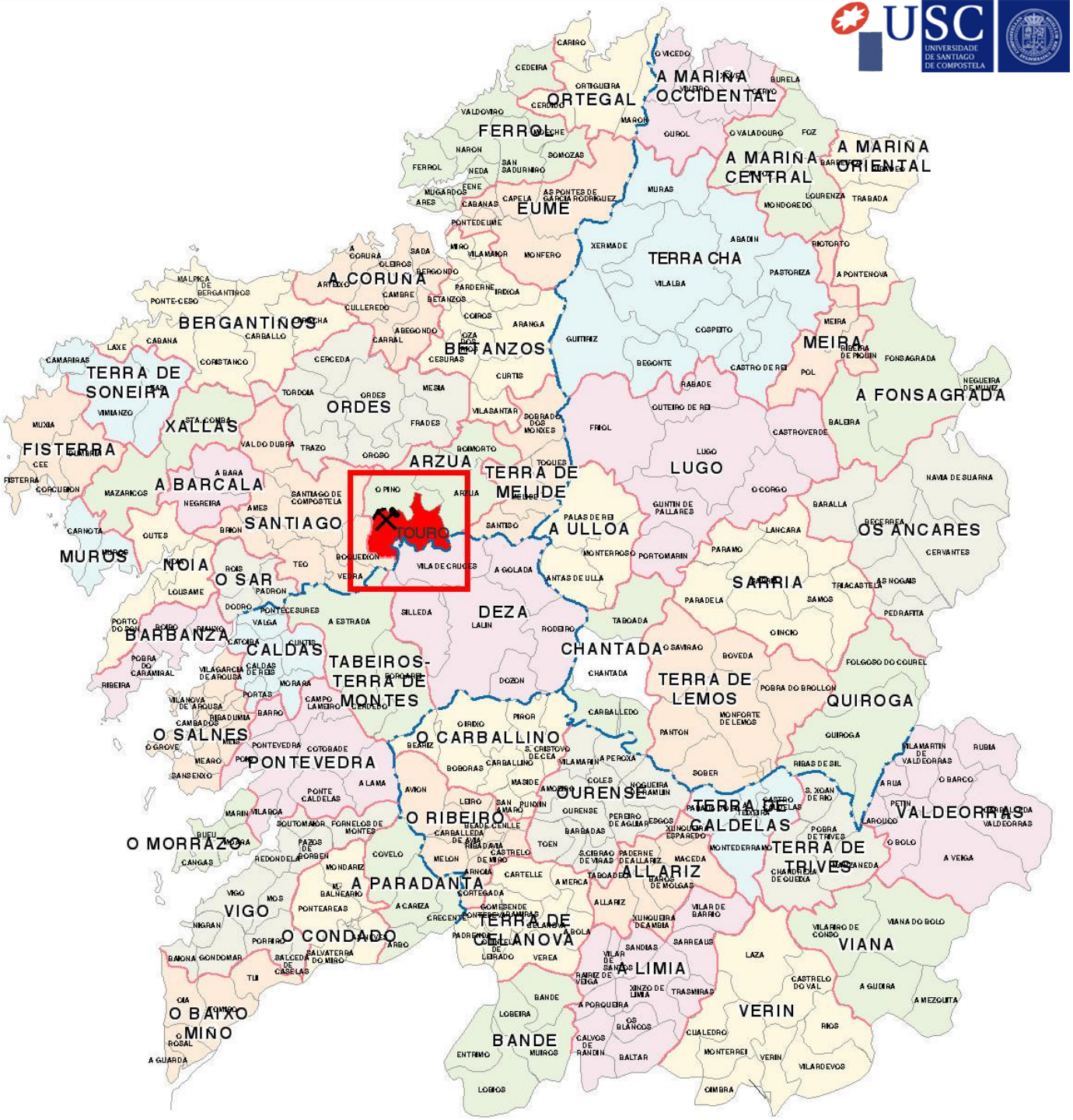


Valorization of non-toxic organic wastes and the Application of Technosols in soil remediation strategies

Centro de Valorización Ambiental del Norte, S.L.
Universidad de Santiago de Compostela


A MARIÑA OCCIDENTAL
ORTEGAL
FERROL
A MARIÑA CENTRAL
A MARIÑA ORIENTAL
EUME
TERRA CHA
A CORUÑA
BERGANTIÑOS
BRIGANZOS
MEIRA
TERRA DE SONEIRA
ORDES
A FONSAGRADA
XALLAS
FISTERRA
ARZUA
TERRA DE MELIDE
LUGO
A BARCALA
SANTIAGO
TOURO
A ULLOA
OS ANCARES
MUROS
NOIA
O SAR
SARRIA
DEZA
BARBANZA
CALDAS
CHANTADA
TABEIROS-TERRA DE MONTES
TERRA DE LEMOS
QUIROGA
O SALNES
O CARBALLINO
PONTEVEDRA
OURENSE
TERRA DE CALDELAS
VALDEORRAS
O RIBEIRO
O MORRAZO
A PARADANTA
ALLARIZ
TERRA DE TRIVES
VIGO
TERRA DE CELANOVA
O CONDADO
VIANA
A LIMIA
O BAIXO MIÑO
BANDE
VERIN

$$2S_2Fe + 7O_2 + 2H_2O \leftrightarrows 2Fe^{+2} + 4SO_4^{=} + 4H^+$$

$$Fe^{+2} + 3H_2O \leftrightarrows 3Fe(OH)_3 + 3H^+$$

$$S_2Fe + 14Fe^{+3} + 8H_2O \leftrightarrows 15Fe^{+2} + 2SO_4^{=} + 16H^+$$

550 Ha

What if we thought about making an integrated environmental management procedures in place to look for waste disposal?

- It is to return the items to the natural biogeochemical cycles, with health guarantee, fast and, if possible, solving other environmental problems through the use of the positive aspects of waste in each situation.

About us

Centro de Valorización Ambiental del Norte, S.L.

- Young company, created in 2012.
- Our installations are located in the old Mines of Riotinto in Touro - La Coruña. We began our activity in September 2013.
- The R&D linked to the recovery of waste , to the minimization of impacts and the implementation of systems for bioremediation are gathered in our foundational objective

What is a Technosol?

- Solid mixture of natural or synthetic materials, mineral or organic, which is placed on the surface, allows rapid integration of anthro-geomorphic residual components in biogeochemical cycles as well as compliance with environmental and productive functions of the soil, improving the environmental situation preceding (Macías, 2004, 2007)
- Technosols waste derived ecotoxicity shall be free and have structural characteristics and nutritional quality to ensure their medium, minimizing environmental hazards and health and hygiene from their application, (ITR01/08).

Waste-derived Technosols must meet the ecological functions of soils

1) Food and biomass production.
2) Storing, filtering and transformation.
3) Habitat and gene pool.
4) Physical and cultural environment for mankind.
5) Source of raw material.

Furthermore, these features must be adapted to the conditions in the area of use to improve existing conditions.

Some possible objectives

Technosols can be made on demand to solve environmental problems and pollution

- Stabilize labile organic carbon.
- Immobilize heavy metals and / or toxic anions
- Balancing nutrients in degraded half

Technosol

1) Mineralogical composition and biogeochemical properties suitable.
   - Polluting processes neutralize acid-base characteristics.
   - Reducing capacity / oxidant depending on the type of problem.
   - Complexing Ability.

   Submit reactive surfaces capable of anion adsorption reactions / cations.
2) adequate physical properties (porosity, texture, ...). Water holding capacity, pore structure with formation of stable aggregates.
3) Capacity stabilization of C.
4) Adequate soil life.
5) No ecotoxicology.
6) Ability to evolve in soil processes.

Wanted

1. Solve the management of waste through recovery and the recovery of degraded or contaminated on an affordable and environmentally correct.
2. Eliminate or greatly reduce waste impacts on sensitive systems (water, air and biota).
3. To stabilize carbon in soils and biomass.
4. Recycling nitrogen, phosphorus, potassium and other macro and micronutrients.
5. Comply with the productive and environmental functions in accordance with the European strategy on soil protection.

Solutions for mining.


PHASE 1.- Degraded slope.


Excavation platform


Reactive WETLANDS with Technosols


PHASE 2.- Slope with Technosol.


Degraded tip


Recuperated tip.


Recuperated tip.


PHASE3.- Restaured slope.


Tip WITH and WITHOUT Technosols.


Recuperated tip.

Comparison between the initial and Technosols

	Initial Mine Soil	Common Technosol Touro mine
pH	2.8	8-10
% C	<0.01	2-10
% N	<0.01	0.2-1.0
% Spiritic	2-3	<0.1
Acid neutralizing capacity	Null	Very high
Biodiversity	Extremophiles	High
Toxicity	Very high (H^+, Al, $SO_4^=$)	Null
Productivity	Null	Normal-High


Technosols
(6 years)
Original soil
vegetation
(9 years)

In which soil can be used Technosols

- Recovery of contaminated soils, quarries, mines and contaminated industrial and urban environments and / or degraded. Erosion control.
- Complement the previously stacked topsoil soil restoration activities, landfills, ...
- Substitute for peat and topsoil sealing work or land reclamation works affected by urban, industrial, infrastructure, etc..
- High intensity forest crops (eucalyptus, poplar, ...)
- Timber production forests.
- Agricultural soils in the process of degradation of surface horizons pollution, impoverishment, loss of organic matter and fertility, excessive tillage, compaction and loss of structure, ...
- Forced crop soils with high nutrient demand.

What soil should not be used compost or refuse derived Technosols?

- Protected areas or natural and scenic interest.
- Highly sensitive soils very susceptible to change its properties: fens, marshes and fens, hydromorphic soils, Podzols, Gypsisols ...
- Unique soils to be protected as a heritage edafogenético: Some Vertisols, Mollisols, Podzols, Calcisols, Ferralsols, Andosols, Ultisols and Alfisols red ..
- Climax forests.
- Natural grasslands.


The spontaneous growth shows no ecotoxicity Technosol

Environmental benefits of using waste-derived Technosols

- Recovery of degraded soils and / or contaminated.
- Minimization of waste landfilled or treatment plant.
- Quick integration in biogeochemical cycles.
- Saving natural resources as "topsoil", peat, ... in land reclamation work, landfill sealing, ...
- Reduction of waste management costs while minimizing energy costs and waste storage.
- Increased utilization of nutrients (N, P, K, Mg, Ca, ...) existing in incorporating waste the food chain and soils with lower costs of fertilizer and amendment for.
- Significant increase in soil carbon sequestration and biomass they support.
- Increased biological activity and biodiversity in degraded soils or in areas where soil has been removed.
- Enhancement of the landscape by increasing the area revegetated and protected from erosion.
- Improving the quality of surface water and groundwater to recover buffer functions, filter and purification of soil themselves.
- Increased resistance to the risks arising from contamination
- No new waste produced as other management techniques. Integrated process.

Slideshow where you can see the improvement obtained over the years in the Touro mine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Reactive Wetlands with Technosols

Reactive Wetlands with Technosols

Reactive Wetlands with Technosols

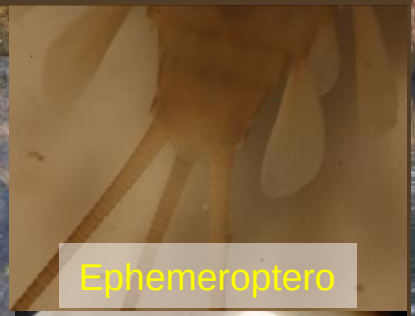
		EXIT
pH	H_2O	7,79
C.E.	$mS \cdot cm^{-1}$	2,2
SO_4^{2-}	$mg \cdot L^{-1}$	1435,5
NO_3^-	$mg \cdot L^{-1}$	9,4639
Cl^-	$mg \cdot L^{-1}$	111,97
PO_4^{3-}	$mg \cdot L^{-1}$	0,1258
Al	$mg \cdot L^{-1}$	0,077
Fe	$mg \cdot L^{-1}$	<0,05
Cu	$mg \cdot L^{-1}$	0,31
Mn	$mg \cdot L^{-1}$	3,36
Ni	$mg \cdot L^{-1}$	0,21
Pb	$mg \cdot L^{-1}$	<0,50
Zn	$mg \cdot L^{-1}$	0,06
Cd	$\mu g \cdot L^{-1}$	1,84
As	$\mu g \cdot L^{-1}$	7,54
Ca	$mg \cdot L^{-1}$	480
Mg	$mg \cdot L^{-1}$	90

		MIDDLE
pH	H_2O	4,83
C.E.	$mS \cdot cm^{-1}$	2,1
SO_4^{2-}	$mg \cdot L^{-1}$	1958,5
NO_3^-	$mg \cdot L^{-1}$	4,09
Cl^-	$mg \cdot L^{-1}$	42,649
PO_4^{3-}	$mg \cdot L^{-1}$	0,1915
Al	$mg \cdot L^{-1}$	2,112
Fe	$mg \cdot L^{-1}$	0,066
Cu	$mg \cdot L^{-1}$	4,42
Mn	$mg \cdot L^{-1}$	14,95
Ni	$mg \cdot L^{-1}$	0,85
Pb	$mg \cdot L^{-1}$	<0,50
Zn	$mg \cdot L^{-1}$	<0,05
Cd	$\mu g \cdot L^{-1}$	7,81
As	$\mu g \cdot L^{-1}$	2,12
Ca	$mg \cdot L^{-1}$	262,5
Mg	$mg \cdot L^{-1}$	117,5

		AMD
pH	H_2O	3,07
C.E.	$mS \cdot cm^{-1}$	3,56
SO_4^{2-}	$mg \cdot L^{-1}$	3958,1
NO_3^-	$mg \cdot L^{-1}$	1,5636
Cl^-	$mg \cdot L^{-1}$	85,793
PO_4^{3-}	$mg \cdot L^{-1}$	0,1164
Al	$mg \cdot L^{-1}$	34,65
Fe	$mg \cdot L^{-1}$	34,35
Cu	$mg \cdot L^{-1}$	1,69
Mn	$mg \cdot L^{-1}$	41,85
Ni	$mg \cdot L^{-1}$	1,89
Pb	$mg \cdot L^{-1}$	<0,50
Zn	$mg \cdot L^{-1}$	2,07
Cd	$\mu g \cdot L^{-1}$	7,29
As	$\mu g \cdot L^{-1}$	3,15
Ca	$mg \cdot L^{-1}$	487,5
Mg	$mg \cdot L^{-1}$	180

Acid mine drainage

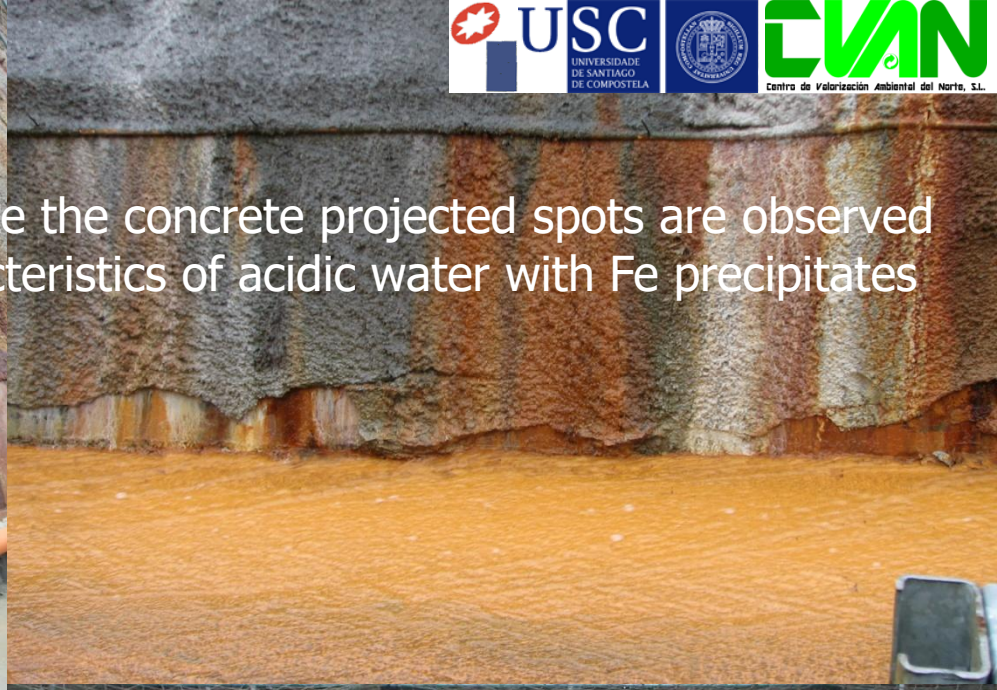
Biodiversity



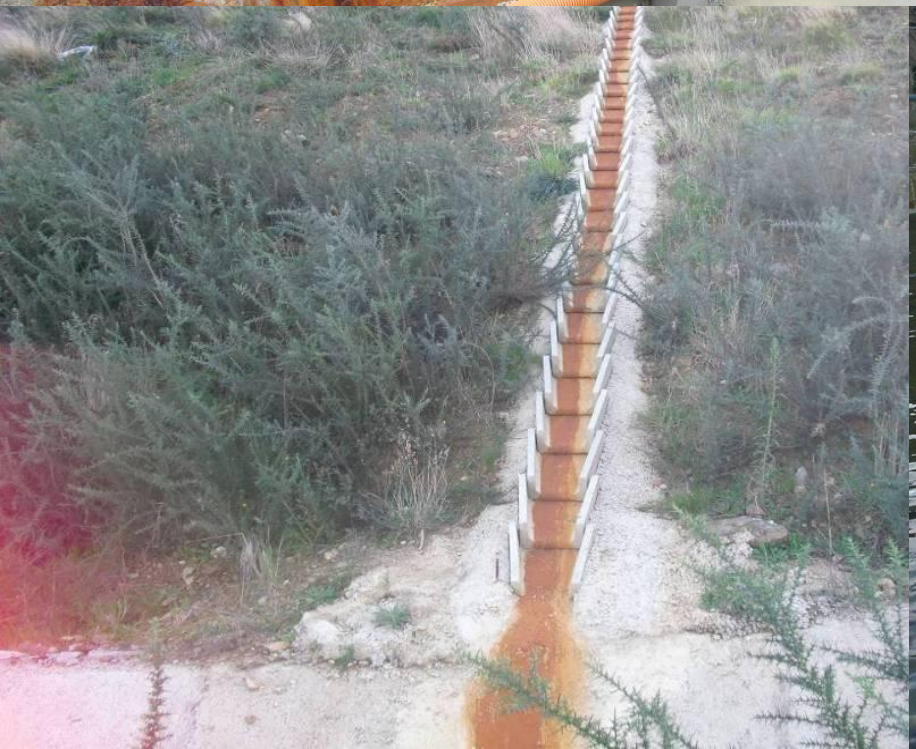
Biodiversity

We have created a food chain where none existed before and that space was so degraded that there were not even insects.
To remedy the conditions applying Technosols has been gradually colonized by different organisms until predators such as foxes and birds of prey.
There are also rabbits and other species of birds such as quail, ducks, herons, ...

Spontaneous colonizing plants. Technosol colonize and create biodiversity. They are usually annuals that are modified as the Technosol is maturing and changing their characteristics in terms of nutrients, pH, etc..



Despite the concrete projected spots are observed characteristics of acidic water with Fe precipitates



Consequences of fish mortality

Solutions for Civil construction.

A8 Slope Vertical Technosol

Dump of El Espiño. AVE Line. A Gudiña

Technosols

Growth of vegetation

Dump of Cerdedelo. AVE Line. Laza

Solutions for Agrifood Industries.

R&D&i Projects.

Project	Year	Financed by	Colaborator
Design, formulation and elaboration of Technosols for the bioremediation of soils contaminated by hydrocarbons and heavy metals through the application of different species of fungi. (MYCOTECHNOSOLS)	2014 - 2015	Axencia Galega de Innovación-Xunta de Galicia. FEDER CONECTAPYMES	Lab. Tecnología Ambiental - USC Dept. Ecología Animal – UVIGO
Application of new mycorrhizal fungi and mycotoxins to the bioremediation of disturbed soils contaminated by shale mining for their rehabilitation as productive ecosystems. (MICOTECHNOSOLS II)	2016 - 2018	Axencia Galega de Innovación-Xunta de Galicia. FEDER CONECTAPYMES	Lab. Tecnología Ambiental – USC
Sustainable valorisation of vitivinicultural waste. (UVATEC)	2016 - 2018	Axencia Galega de Innovación-Xunta de Galicia. FEDER CONECTAPYMES	Centro Tecnológico AIMEN Lab. Tecnología Ambiental – USC
Valorization of organic waste with advanced control and optical monitoring. (ROMEO)	2016 - 2018	Axencia Galega de Innovación-Xunta de Galicia. FEDER CONECTAPYMES	Centro Tecnológico AIMEN Lab. Tecnología Ambiental – USC
Recovery of Organic Waste: Production of Humic Substances (Res2ValHum)	2017-2019	Programa Operativo Colaborativo Transfronterizo España-Portugal (POCTEP) INTERREG V España-Portugal	Lab. Tecnología Ambiental – USC

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CONCLUSIONS

- It is possible to develop "Technosols a la carte" adequate to solve the various problems posed by mines or others sites.

- Technosols, properly designed, meet the environmental and productive functions of soils. They are means of life, soil processes are evolving in terms of training factors which are under and can solve several environmental problems simultaneously. Among others, the waste-derived Technosols are:
  - A new alternative for recovery of waste biogeochemistry rapid integration of nutrients in natural cycles with health guarantee.
  - An aid to climate forcing by setting C and N in biomass Technosol and minimizing the loss to the atmosphere.
  - Control the mobility and bioavailability of heavy metals, Al, As, and other organic and inorganic contaminants.
  - A quick system to recovery the production capacity and restores the environment affected soil and water.
  - Erosion control,…