USA PHYTOREMEDIATION AS A MODEL FOR THE APPLICATION OF *JATROPHA CURCAS* AS A GOLD MINE CLEAN UP TECHNOLOGY IN CHOCO-COLOMBIA

PILOT PROJECT

PAOLA M. RIVAS – UNIVERSITY OF HOUSTON 2012

Law Project Initiative

INTRODUCTION

- COLOMBIA is the second most biologically diverse country on earth and is home of about 10% of the world's species. This biodiversity results from Colombia's varied ecosystems:
  - Tropical rain forests
  - Coastal cloud forests
  - Open savannas
- The biodiversity is increasingly threatened by many different human activities such deforestation and gold mining.
- This paper recommend the use of Phytoremediation technology as a vehicle to counteract one of the main issues generated from the recent "WORLD GOLD BOOM": the disposal of mercury (Hg) into the soils of the State of Choco- Colombia.

A BRIEF HISTORY OF THE GOLD INDUSTRY IN COLOMBIA

- During the colonial period when conquers were drawn to the Americas by a quest for riches, they were soon exploiting the land for its resources.
- When they reached Choco (State situated in the east side of Colombia) a history of gold and platinum mining started by the work of slaves.
- Today, foreign companies are seeking the fabled deposits of ores found in the "Andes chain" thru different mining technologies to exploit gold at large scale, and are creating devastating consequences for the surrounding environment and local population:
  - Hand-dug tunnels have been replaced by open pits
  - Pickaxes are being supplanted by heavy machinery, explosives and gargantuan dredgers.

HISTORY CONTINUATION…….

- Colombia as home of South America's second largest coal reserve and potentially the largest gold mine in the hemisphere, is grapping with complex mining-related issues at big and small scale.
- These issues are intensified by national economic policies that shift priority from agriculture to mining, where there is a lack of legal framework and technical knowledge to balance mining regulation with environmental protection.

ENVIRONMENTAL ISSUES GENERATED FROM GOLD MINING AT SMALL SCALE IN THE STATE OF CHOCÓ

- It is vital to note that Colombia, and specially the State of Choco rural population has been born into a system that continuously place their lives and welfare at a disadvantage and has perpetuated predictable intergenerational bouts of poverty.
- Miners at small scale have two choices: illegal gold mining using questionable process that contribute to enhance the current world highest levels of mercury contamination, or growing illegal coca. The vast majority has opted for the first one.
- It is not a secret that there is a growing threat in Colombia and in other countries that gold mining expands in response of rising gold prices…..GOLD and MERCURY are interdependent commodities: if gold price increases so does *Mercury Pollution.*

ENVIRONMENTAL ISSUES CONTINUATION…

- **The technique use:**
  - Many miners to separate precious gold from common stones, cart their ore/gold to town, where it is mixed with mercury in cylindrical mills filled with steel balls that grind the ore into fine flour.
  - Mercury and gold bind as one, until, surrendered by fire, the more volatile mercury is vaporized from the elemental union and some wastes are dropped into land and or river; being the result, the exposure of large number of people, animals and plants to a high levels of mercury vapor, which in extreme can lead to life-threatening mercury poisoning.
- "People is Mercurized"

ENVIRONMENTAL ISSUES CONTINUATION……

- Nowhere is this problem of mercury contamination more urgent than in Colombia. Gold mining is Colombia's fastest growing industry, with 200,000 small-scale miners producing more than 50 percent of the country's gold. This growth has turned Colombia into the world's leading per-capita emitter of mercury, especially in the states of Antioquia and Chocó.
- **ENVIRONMENTAL ISSUES IN CHOCO:**
  - 8 mining zones are experiencing problems generated from wasted material left behind.
  - The Regional Autonomous Corporation for the Sustainable Development of El Chocó (CODECHOCO) diagnosis summary on the mining state of the department:
  - **Pollution of water sources and soils with approximately 43,000 gallons per year of oil used.**
  - **Pollution of water sources, air and soil with about 3 tons per year of mercury**

CHOCO RAINFOREST

AERIAL VIEW

ILLEGAL
MINE SITE
IN CHOCO

DREDGERS USED IN MINE SITES

- Soil and water contamination
- Deforestation

ENVIRONMENTAL ISSUES CONTINUATION….

- Loss of biodiversity and genetic erosion due to the intervention and destruction of fragile ecosystems.

It is noticeable the deleterious progression of the destruction of forests that appear to be endless. Consequently, the following recommendation models are intended to start the restoration of the forests thru clean up technologies and avoid deepest environmental destruction consequences that would not have any applicable solution. All the offered remediation effectiveness is subject to further tests to be developed by the appropriate entities

EPA GREEN REMEDIATION / PROMOTION OF ENVIRONMENTAL STEWARDSHIP

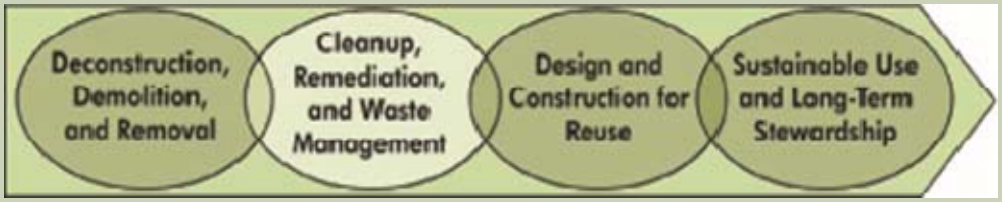
- Is part of EPA mission to protect human health and the environment.
- EPA has promoted clean up strategies using natural resources and energy efficiently to complement primary remedies for clean up goals:
  - To restore contaminated sites to productive use
  - To reduce associated costs
  - To promote environmental stewardship
  - To incorporate sustainability principles that can help increase the env'l, economic and social benefits of the clean up: (BMP)
- Benefits of GR: 1. Reduces demand placed on the environment
  2. Avoids potential collateral env'l damages.

EPA / BEST PRACTICES MANAGEMENT PPLE.

- To improve environmental performance of business sectors
- To incorporate methods for conserving and improving H20 quality , energy efficiency, managing and minimizing toxics, reducing emission of air pollutants etc.

*** NO SINGLE SOLUTION EXIST ** : Site specific strategies must be taken into account

- BMP's incorporated in all phases of the remediation : investigation>remedy construction>operation of treatment system>monitoring of treatment and progress>site close out:



PHYTOREMEDIATION TO CLEAN UP CONTAMINATED SOIL

- DEF: Phyto=plant / remediation= correct. Emerging technology based on the use of plants to clean up polluted sites.
- Proposed plant to claim Hg contaminated soil in Choco: *JATROPHA CURCAS:* specie of flowering plant native to the Americas tropics (MX – CA) known for reclaiming and upgrading degrading soils.
  - In Panzhihua-China a mining base, JC seeds were exposed to concentrations of Hg. The results :>capacity of phytoremediation of Hg with no significant toxic symptoms. >Hg ions were mainly retained in the roots
- PHR= can be used along or in some cases in place of mechanical clean up methods

METHODS OF PHYTOREMEDIATION

- Used to clean up: pesticides, solvents, explosives, crude oil, metals, etc.
- Methods: EPA resource guide
  - Phytoextraction: uptake and translocation of metal contaminants in the soil by the plant roots into the aboveground portions of the plant
  - Rhizofiltration: absorption onto plant roots of contaminants that are in solution surrounding the root zone.
  - Phytostabilization: use of a plant to immobilize contaminants in the soil and water thru absorption and accumulation by roots.
  - Phytodegradation: breakdown of contaminants by the plant by metabolic process within the plant.
  - Rhizodegradation: breakdown by microbial activity
  - Phytovolatilization: uptake and transpiration of a contaminant by the plant with the release of the contaminant or a modified form to the atmosphere, passing to the leaves and to volatilize at low concentrations.

REGULATORY FRAME WORK IN USA

- Federal regulations have not been developed for PHR / BMP / EPA Matrix
- Existing federal and state regulatory programs
- Remedy selection and performance varies in federal & state programs / but goals remain common:

1. RCRA= Resource Conservation and Recovery Act: > treatment storage > closure requirements : disposal units closed by removal or decontamination (clean closure) / or closed with waste in place (land field closure). Based on performance / no design standards are stipulated.
2. CERCLA = Comprehensive Environmental Response, Compensation and Liability Act / Super Fund : Remedial actions must>protect human health and environment > be cost effective > must use permanent solutions to the max extent.

REGULATORY FRAME WORK CONT'……..

3. NCP (National Oil and Hazardous Substances Pollution Contingency Plan): Nine evaluation criteria to be used in a detailed analysis of clean up alternatives similar to CERCLA: > protection of human health and env't > long term effectiveness and permanence > reduction of toxicity or mobility thru the treatment > community & state acceptance

4. CERCLA EXEMPTIONS FOR LIABILITY: Any co. or individual contracted to perform investigation of clean up activity is exempt of liability in CERCLA sites…> except for negligence or intentional misconduct.

5. CLEAN AIR ACT: 1996 new performance standards and Emissions guidelines for Municipal Solid Waste Landfills:>Any site contemplating the use of PHR need to consider requirements of F/S/Local government programs to regulate emissions from municipal solid waste landfills.

REGULATORY FRAME WORK CONT'……..

- EPA + UNIDO (United Nations Industrial Development Organization): working on global mercury projects at small scale gold focused on BMP to reduce occupational exposures, emissions and mercury use / Brazil.

LIMITS OF PHYTOREMEDIATION

- **Root System:** PHR requires that contaminants be in contact with the root zone of the plants > plants must be able to extend roots to the contaminants = JC has deep roots.
- **Growth Rate:** More time is required for PHR as compared with other traditional clean up = JC first harvest is early as 180 days.
- **Contaminant Concentrations:** Sites with widespread/ low to medium levels of cont. are the best candidates = no level is yet determined in Choco.

LIMITS OF PHYTOREMEDIATION

- **Impacts of contaminated vegetation:** The fate of the metal is a concern/ metal accumulating plants will need to be harvested and recycled or disposed by means of applicable regulations / but JC does not need further treatment.

OTHER CONSIDERTIONS & RISKS

1. **Technical:** Laboratory studies as primary evidence
2. **Prior application of PHR:** As an indication of acceptability.
3. **Economic:** PHR is 50% to 80% lower than other alternatives.
4. **Native plants are more desirable:** but non native are also acceptable if previously introduced with no ecological risk ,and if are unable to propagate effectively in the wild.
5. **PHR is an interim measure:** may not be selected as final technique / but it is preferable to leave the waste site untreated.

CONCLUSIONS

- Discontinue completely practices of illegal gold mining? >> very idealist
- Modify mining practices to improve health standards and damage to the environment >> go back to artisanal methods/ORO ECOLOGICO?
- Crack down illegal operations
- Better education for miners on health hazards / should be instructed in proper clean up and disposal methods
- **Regardless….an environmental damaged is created and immediate action is needed to help clean up the mess in CHOCO.**

Thank you.