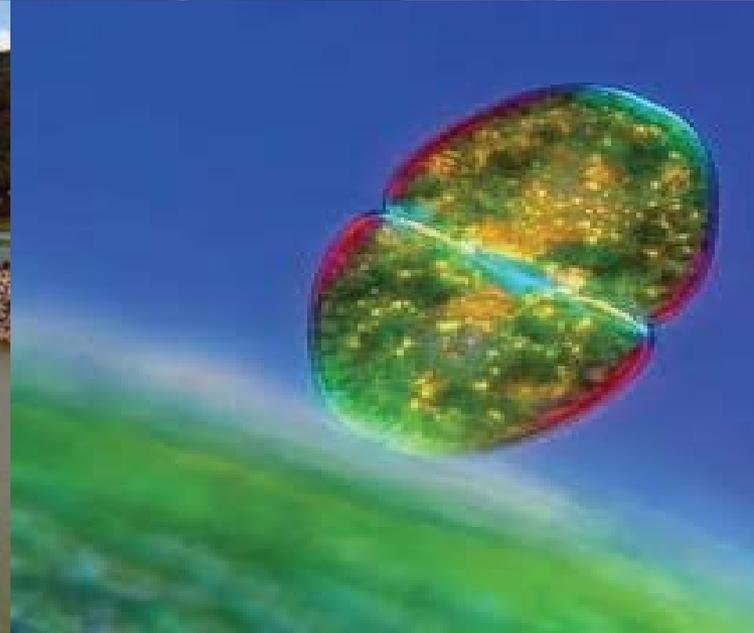


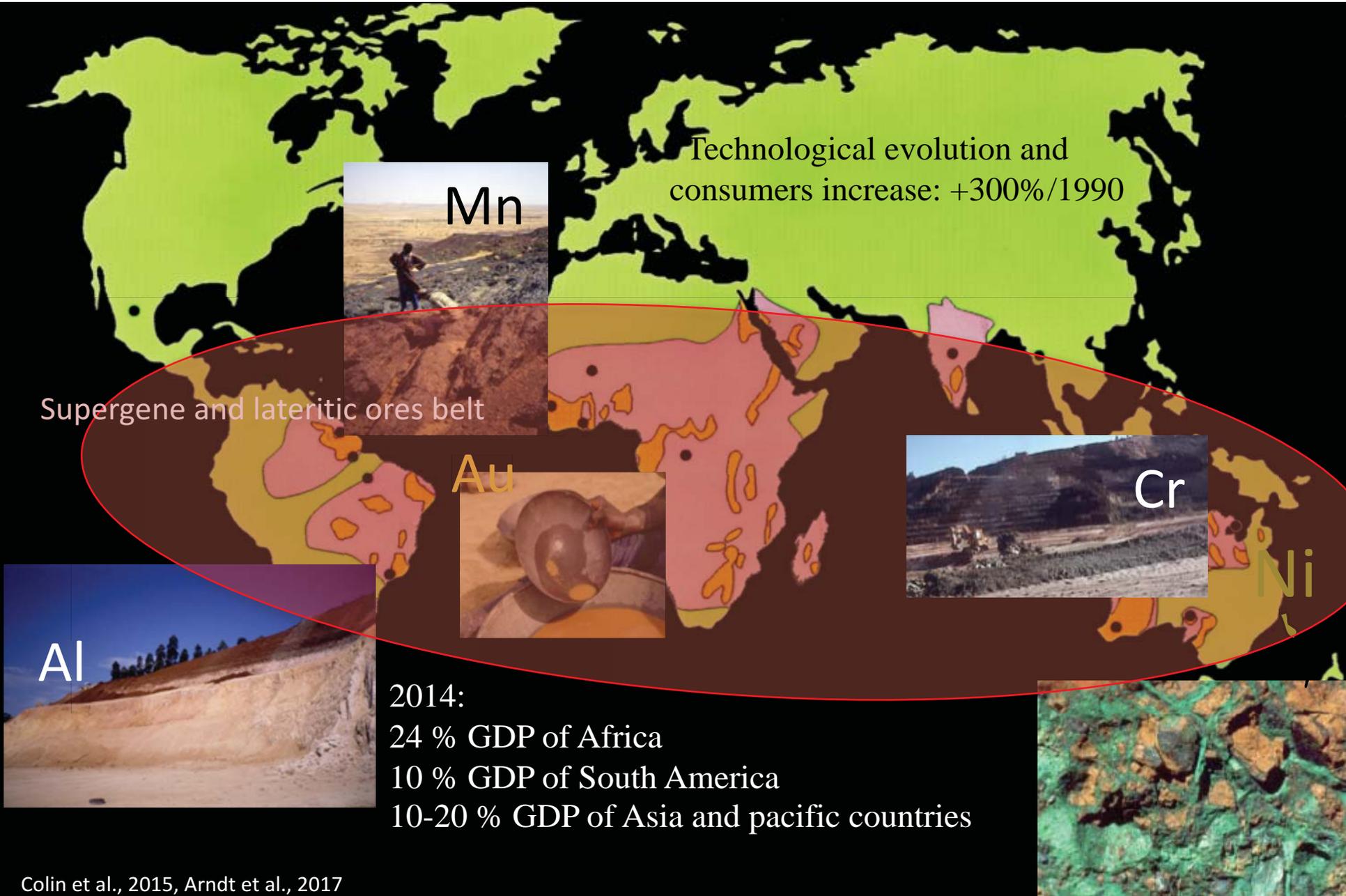
Mining activity and circular economy: oxymoron or new paradigm?

PECC Bozeman meeting, September 2017

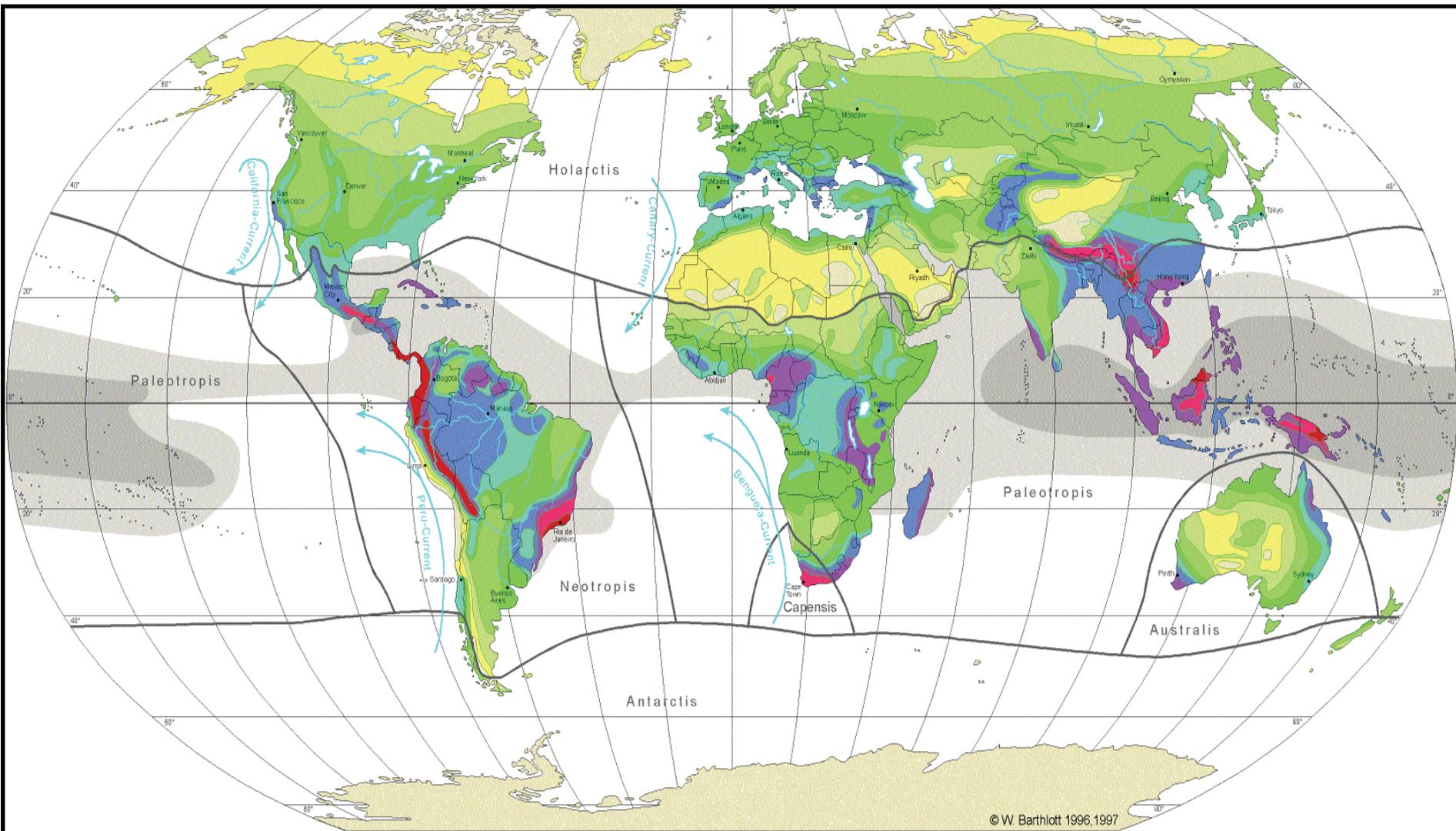
F. Colin IRD CEREGE Aix en Provence, and Nouméa, France
Presented by J.L. Le Bideau, Paris I University, Panthéon Sorbonne,
France



Mining activity : world development issues with regards to increasing demand for metals and mineral products



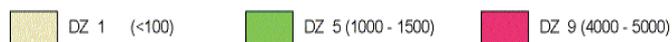
Biodiversity and natural renewable substances protection and valorisation: world development issues



© W. Barthlott 1996, 1997

Robinson Projection
Standard Parallels 38°N und 38°S
Scale 1: 130000000

Diversity Zones (DZ): Number of species per 10.000km²



sea surface temperature



W. Barthlott, N. Biedinger, G. Braun
F. Feig, G. Kier, W. Lauer & J. Mutke 1997
modified after
W. Barthlott, W. Lauer & A. Placke 1996
Department of Botany and Geography

Mining activity: potential environmental and societal negative impacts

The extraction of non sustainable ores and their metallurgical refinement may induce numerous risks at local and global scale, at short, medium and long term such as for example:

-loss of cultural identity and of societal cohesion, land and ecosystem degradations, loss of biodiversity, Dutch disease, impact of GHG such as climatic changes

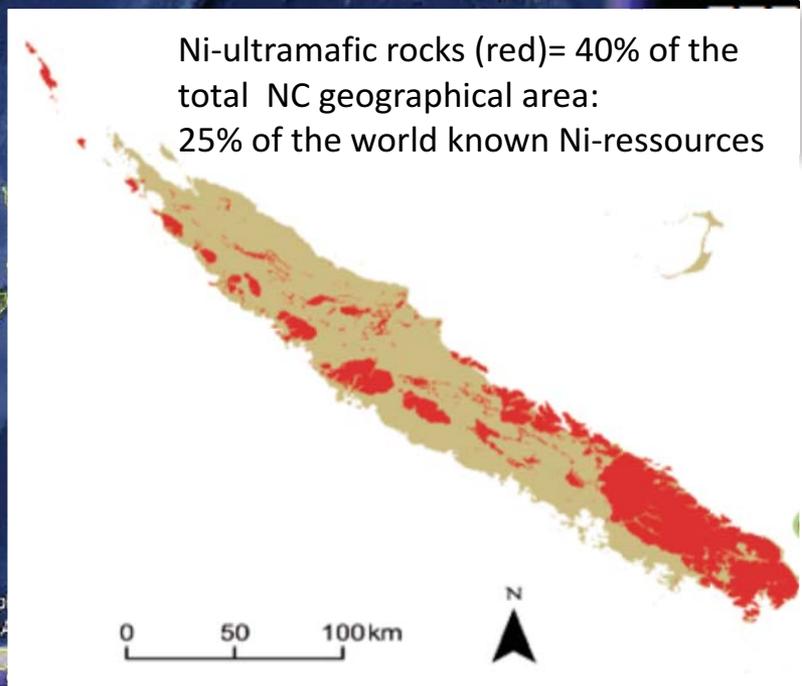
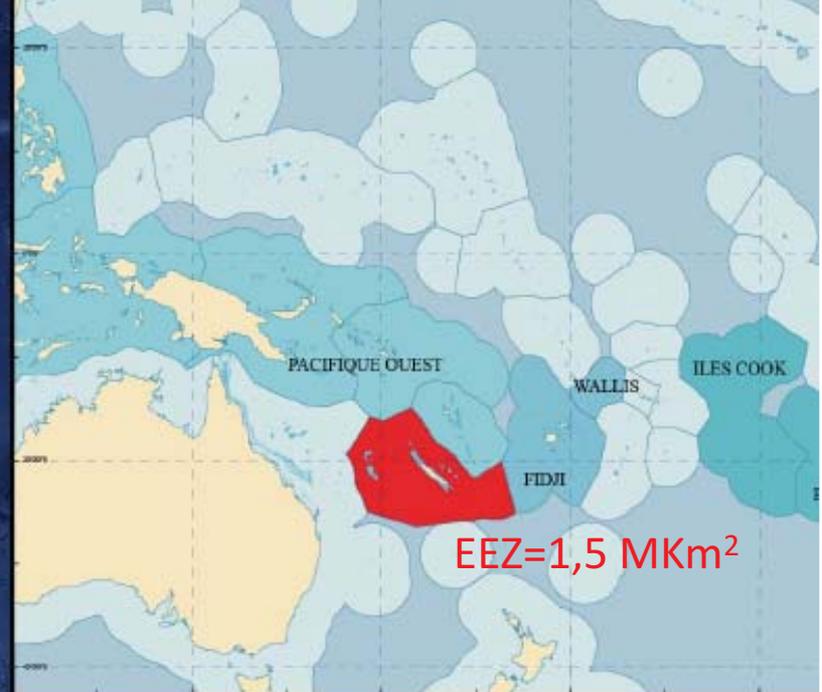
Since 1992 Rio agreement: increasing international political awareness:
necessity of subsequent development of appropriate policies implementing to consider both positive and negative externalities in Life Cycle Analysis (LCA) of mining projects and ores uses

Conjugating economic and environmental issues need to apply non linear economic and development concepts such as « circular economy » : is it really applicable in mining industry?

The case study of the New Caledonia nickel industry: the importance of on going collaborative and multidisciplinary R&D research programs



Geographical and global geological context



Historical mining

Jules Garnier (1864)



Ni-Fe and Ni-Si ores



First artisanal mining near 1900



SLN Doniambo pyrometallurgical plant > 100 ans



Ni industry: First impetus of the “economic and societal development” during last century and strong nexus with the political status evolution of the New Caledonia French “sui generis collectivity” from colonial to post colonial present day periods (Matignon agreements, 1989; Bercy protocol, 1998; Noumea agreement, 1998-2018)

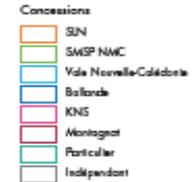
From 1998 to present day: Promotion of the mining activity accompanied by tax-reducing appropriate measures through 3 main world-class mining project developments

Attributed Mining concessions:

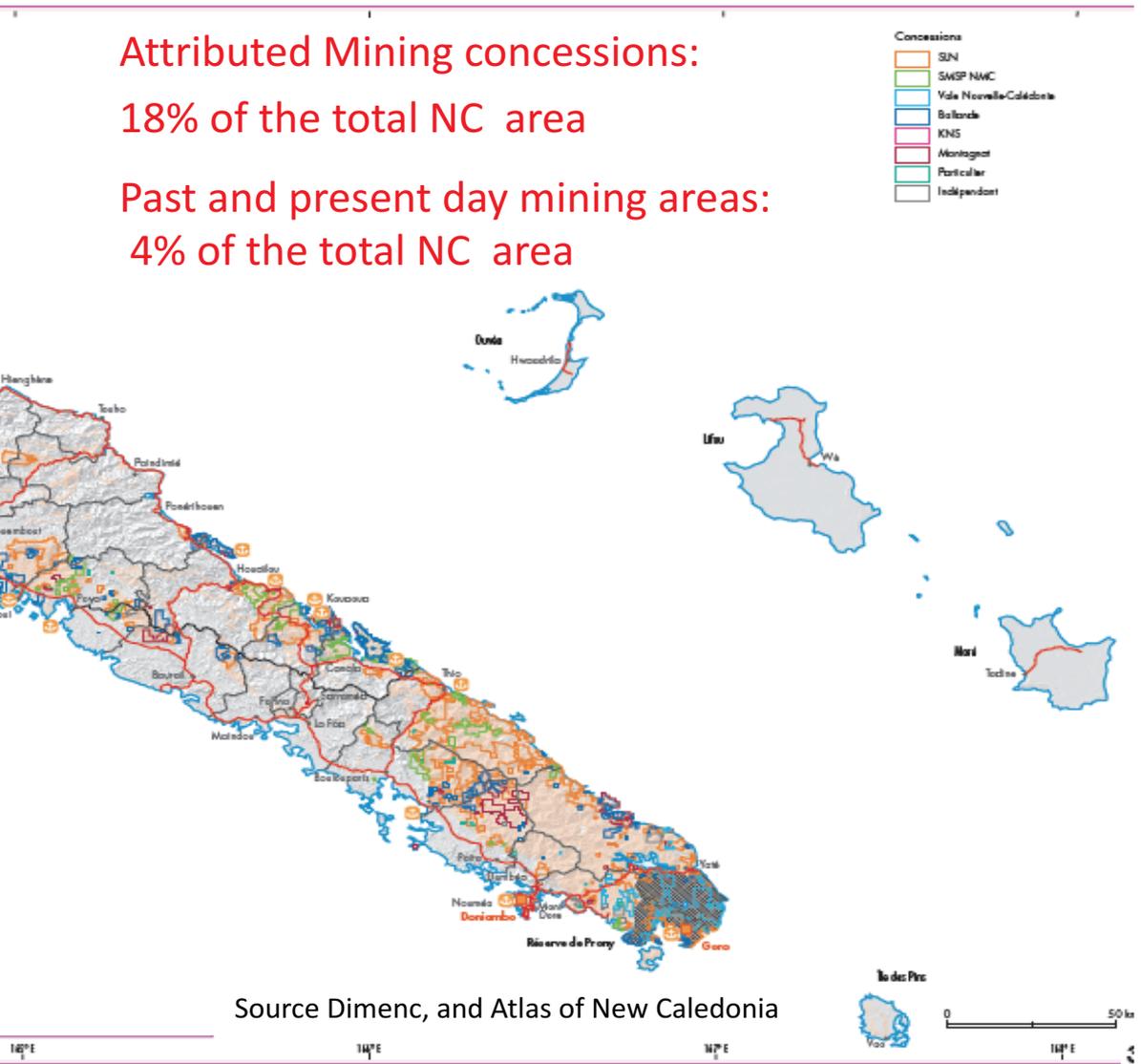
18% of the total NC area

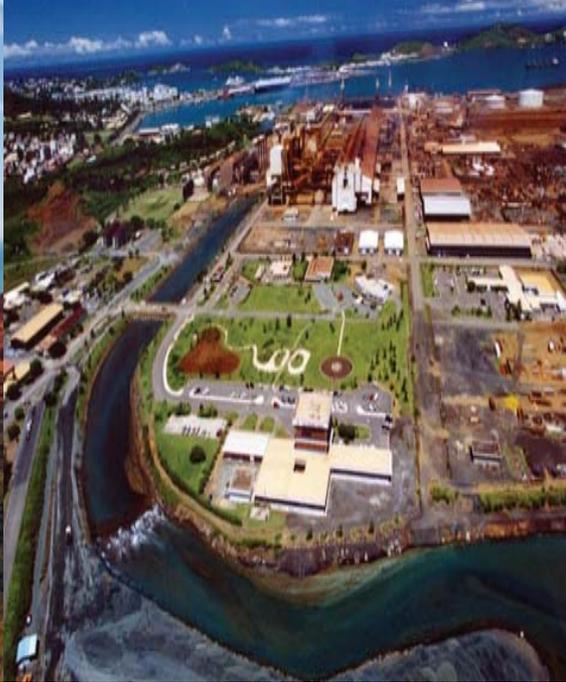
Past and present day mining areas:

4% of the total NC area



20 000 hectares of degraded soils (2008)





SLN-ERAMET development to reach a production of 75 000t Ni/year by pyrometallurgy of $>2,5$ NiO % silicated ores)

Goro Nickel project (South province) (now VALE-INCO) to reach a production of 60 000t Ni/year by hydrometallurgy of 1,5 to 2% NiO iron-rich Ni-ores



Koniambo Nickel project KNS (SMSP-Glencore), North province, to reach a production of 60 000t Ni/year by pyrometallurgy of $>2,5$ NiO% silicated ores)

Exceptional natural terrestrial ecosystems

Mondial biodiversity hot spot



Ecosystems very sensitive to natural and anthropic perturbations (deforestation and land degradation by fire, farming, urbanization and mining)



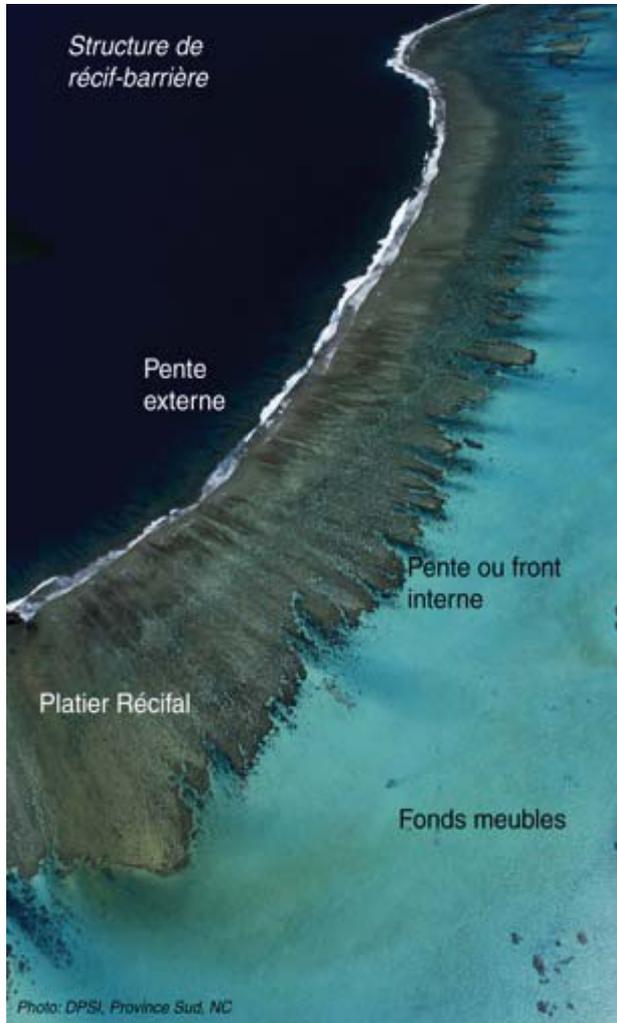
80% of endemic species

Exceptionnall natural marine ecosystems

1000 Km of barrier reef, lagoon and fringing reefs

Ecosystems very sensitive to natural and anthropogenic perturbations (terrigenous and chemical inputs, tourism pressure, overfishing, climatic changes)

UNESCO world heritage list since 2008 (2/3 of the total lagoon area)



The critical zone: an holistic full-size area

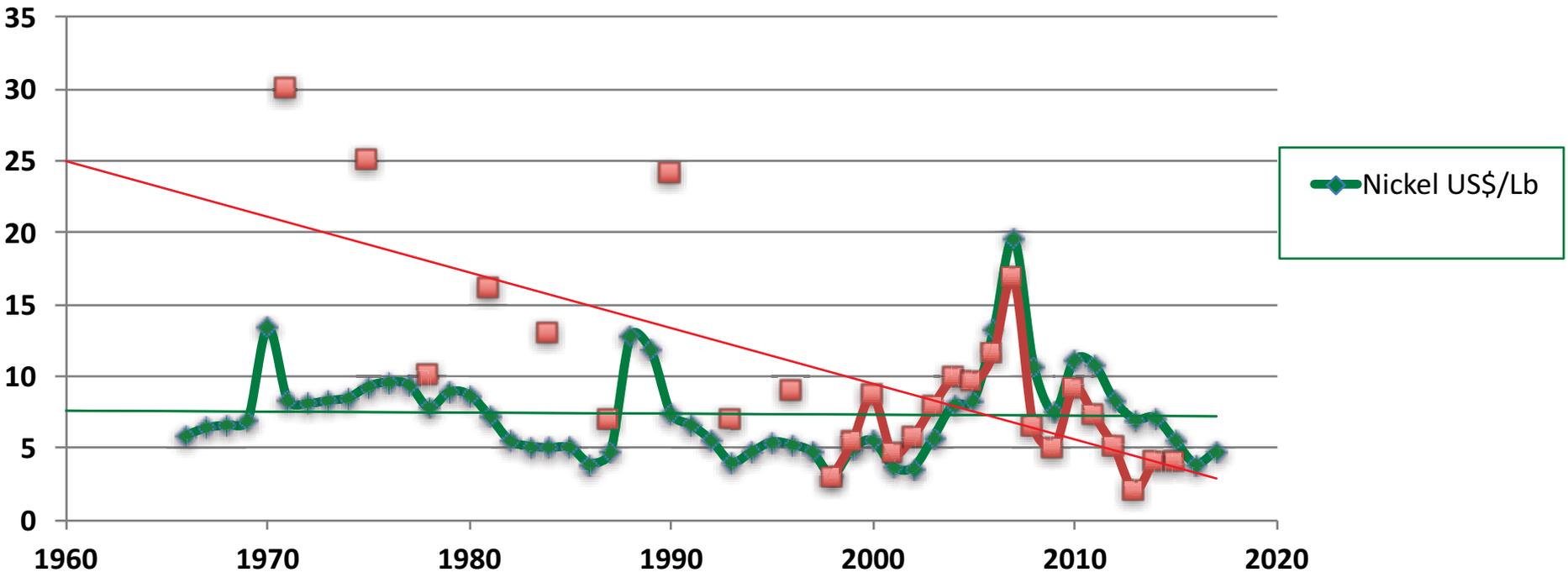
investigated since 2000 by multidisciplinary (“hard and human sciences”) and multiscale (space and time) R&D PPP approach to understand, anticipate and reduce negative changes from mining activity

Leading to a tremendous increase of shared knowledge and skills development and acquisition, inducing dedicated and appropriate decision support system towards public and private operators:

- exploration methods
- exploitation processes
- initial global ecosystem reference status elaboration,
- environmental mining impacts (human, soils, water, air, plantes, animals) and survey of impacts through indicator monitoring
- restoration, and preservation of degraded land and biodiversity
- value of land and value usage conflicts, environmental law
- spatial and temporal analysis and interoperability of data
- dissemination of scientific knowledge and so on.....



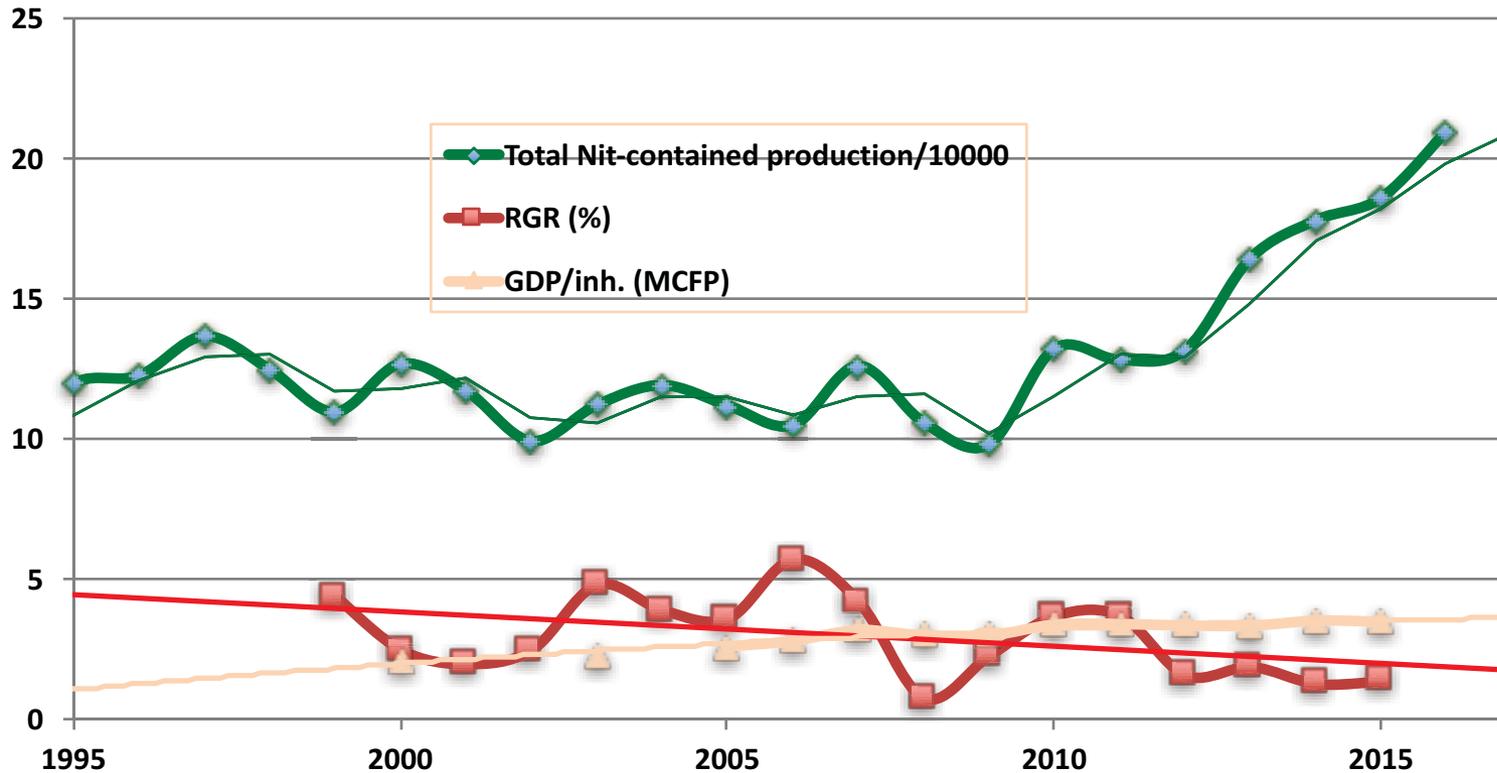
Nickel prices volatility (LME) and decreasing added value trend % to NC GDP



Global correlation between the nickel price(with high volatility) and the Ni industry economical inputs to NC GDP until 2010

Decreasing trend since 1960 of the Ni industry weight input in the NC economy, with a marked downward trend toward very low values since 2010.

Decorrelation of Ni production versus real growth rate from 2008



From 2008-2010 to present day: high increase in nickel production, sensible historic decrease of the real NC growth rate and GDP steady state



Necessity to define new strategies about, from, beyond mining activities taking into account:

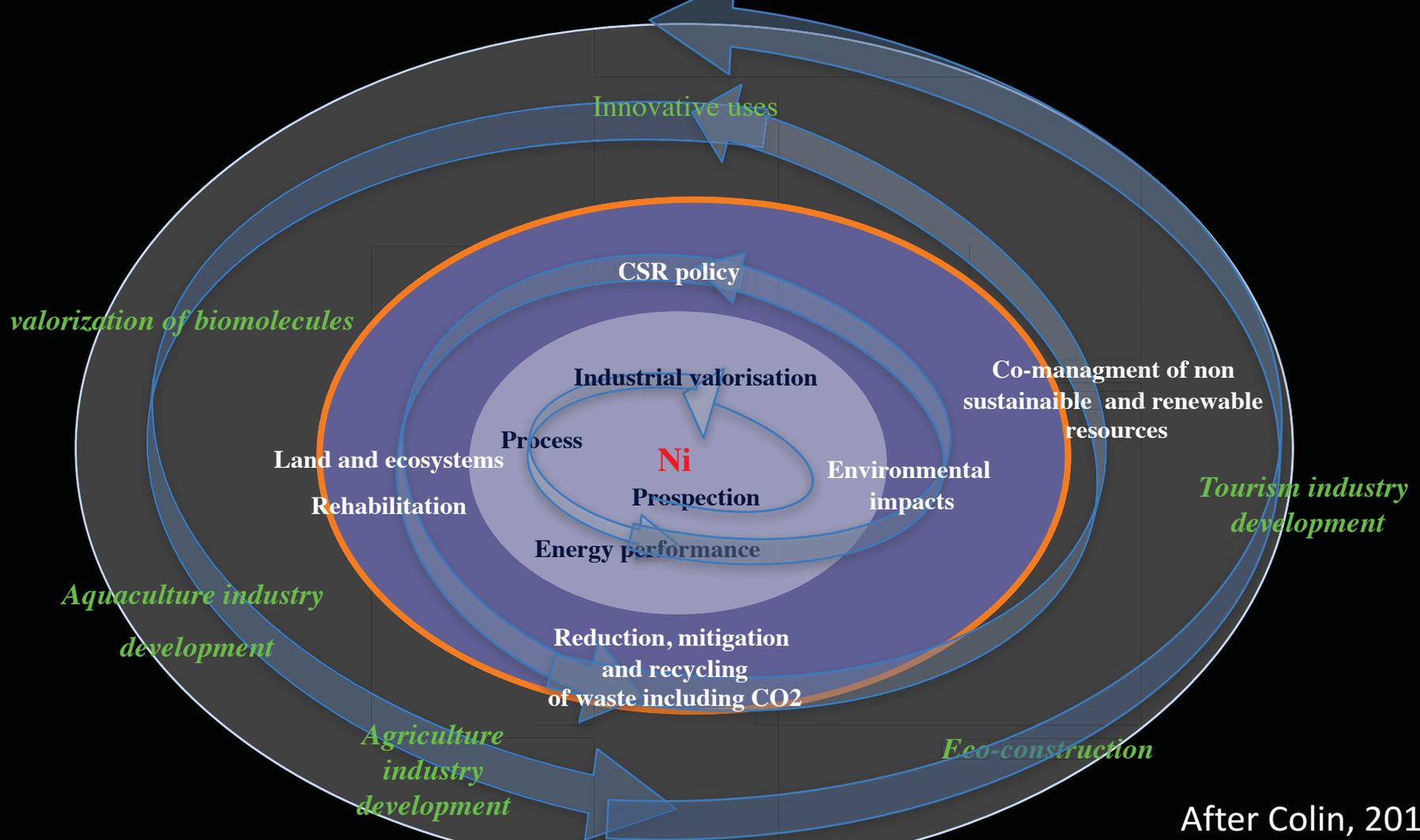
- the transitional economical and societal period (end of the 1998-2018 Noumea agreement)
- the macroeconomic issues resulting from the worldwide 2008 crisis impacts
- the important role of Asia in controlling nickel and stainless steel markets
- the NC local paths of the economical indicators
- the degradation of the natural capital (extracted nickel and degraded ecosystems)
- the richness of the ecosystems (natural and heritage capital)
- the increase of intangible and human heritage capital through the culture diversity, the knowledge economy, and the skill development :

We propose, from R&D results, a model of holistic valorization of “mining ecosystems” through open and innovative multi-scale circular economy approaches

Model of mining activity through intended virtuous circular open economy spiral

cultural identity and societal cohesion strenghtening

diversification through innovative open circular economy



From Research lead since 2006 by IRD/UNC/IAC to develop appropriate protocol to restore mined degraded soils by endemic species, a new approach has been developed with CNRS to use metal bioaccumulator plants that produce biocatalyst for industry.



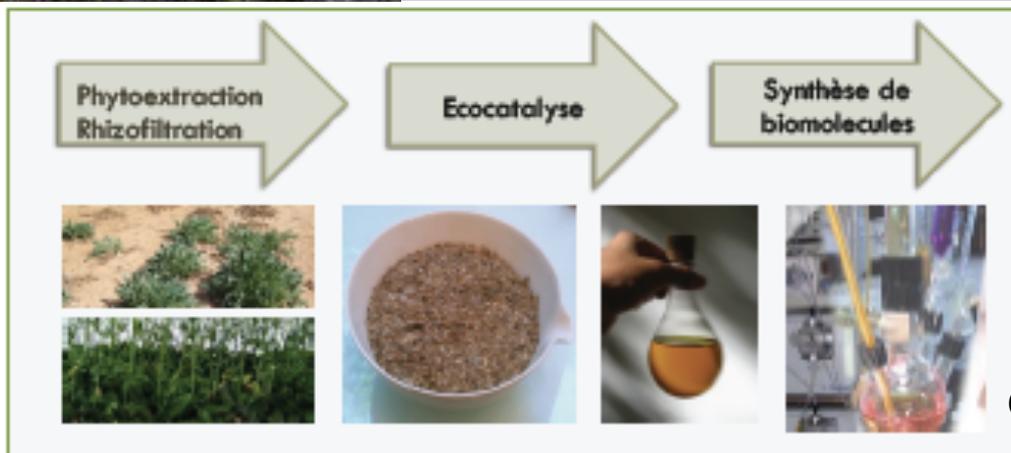
Chim Eco

6 ha de réhabilitation par phytoextraction

Geissols pruinosa

Grevillea exul rubiginosa

Grevillea meisneri



Grison et al, (2012-2017)

Biorecycling of CO₂ by endemic microalgae production in relation to metallurgical and coal fired power plants in order to create a new green industry.

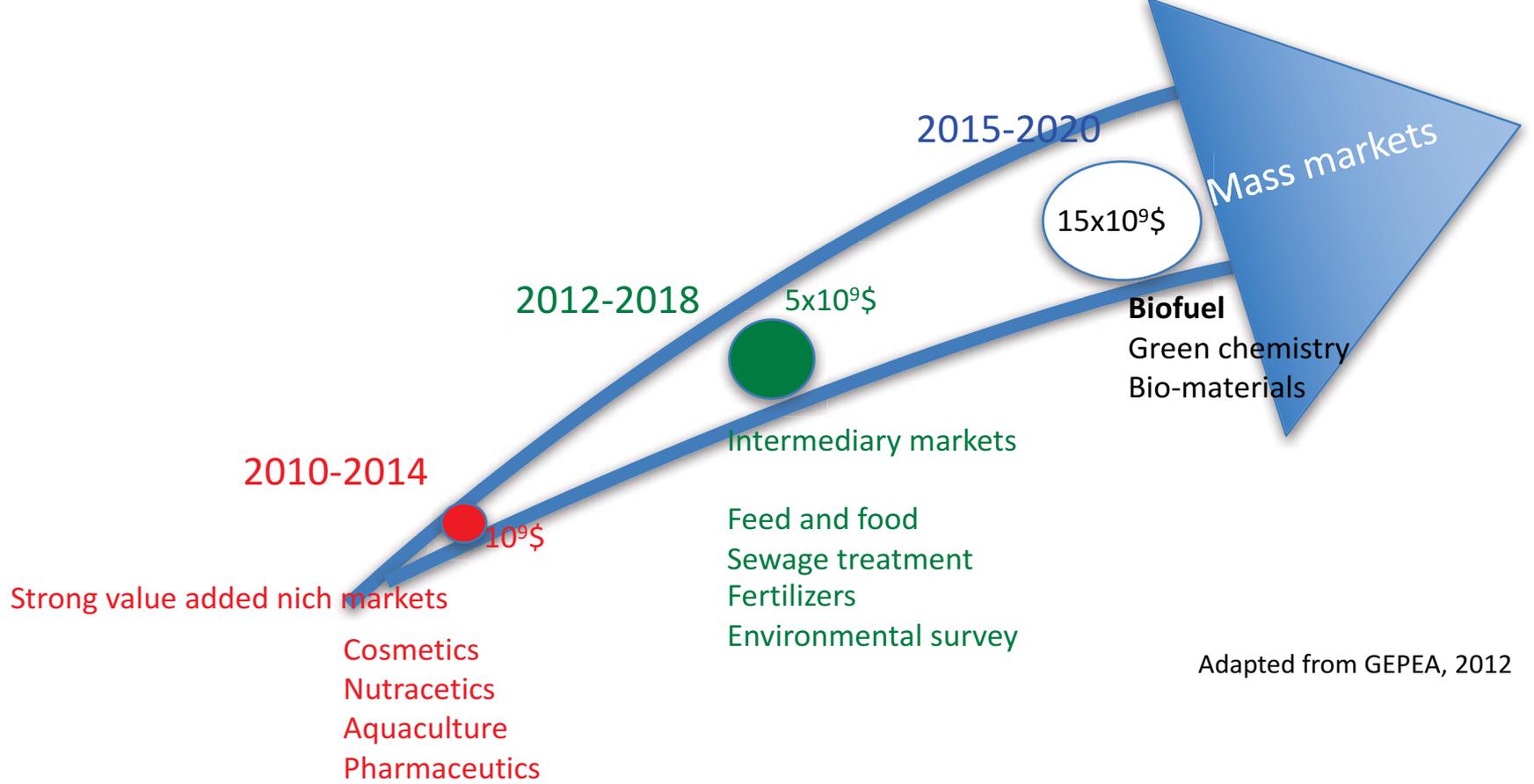


Labo de Foué

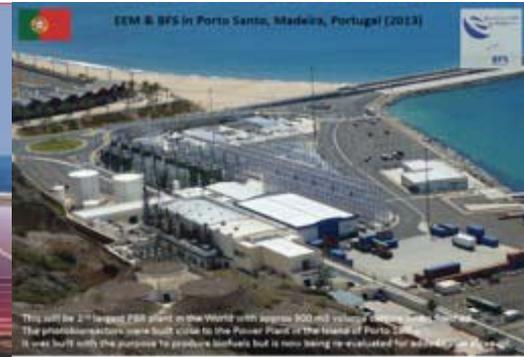
Labo de st Vincent



ADECAL-Technopole of NC, IRD, IFREMER, and UNC 2011-2020



Numerous potential applications in mining industry itself:
 CO2 biorecycling, biofuels, sewage treatment of industrial and domestic waste....



conclusions

- The concept of circular economy, if focuses only on the mineral resource exploitation, would require that the mineral would be exploited with similar kinetics compared to its geologic genesis time, or through a market compatible with the secondary recycling of the considered mineral.
- Yet, neither of these two options is actually physically or socially possible, taking into account the increasing demand of mineral and metals. In addition, the development of subtropical and tropical countries is strongly dependent upon primary mineral resources, as producers and consumers.
- On the other hand, the mining activities generate numerous societal and environmental risks, negative and unacceptable impacts on the natural capital, that will be a sustainable source for future generations.
- Positive and negative externalities have to be qualified and quantified before the exploitation starts, and have to be taken into consideration in decision-making processes.
- From the on going research performed in New Caledonia, we propose an holistic and realistic model based on the voluntary intention to enforce the global mining activity into a progressive upward virtuous spiral. This would require an ever-growing application of the principle of an open and innovative circular economy, to the entire life cycle of a given mining project, going beyond the “*stricto sensu*” primary resource exploitation.

This approach would allow to make the mining project comprehensible for all the implicated parties, with transparent processes based on -a clear wealth-sharing arrangement involving all relevant stakeholders, -a coconstructed CSR, a reduction of the negative impacts, - a mitigation and a biorecycling of the waste, a restoration of the degraded land, a concomitant valorization of both the mined unsustainable and the regional renewable resources of the so-defined “mining ecosystem”.

R&D programs have to be very involved in the support as well as in the follow-up of mining initiatives. The research has to be collaborative, multidisciplinary, with a substantial participation of social and human sciences, undertaken through every range scale from the satellite to the atomic one, and extended at the suitable regional dimension.

Only such appropriate scaling of studies might provide the necessary conditions for moving from oxymoron to a new paradigm by producing immaterial and human capitals through knowledge acquisition.

This will allow to put the mining industry, thus considered as a transitional economic vector, into the virtuous spiral of the energy transition and ecological efficiency, promoting diversification and economic dynamics through open innovative circular economy models:

A stronger link between the living and the inert worlds, to advance human welfare in the spirit of the sustainable development goals.