Leibniz Institute of Ecological Urban and Regional Development

Cleaner production, mining optimizing approaches and material flow analysis

MAREX Workshop, Hoa Binh, Vietnam, November 2017

MAREX Publication Series – Issue 4

Imprint

Cleaner production, mining optimizing approaches and material flow analysis –
MAREX Workshop, Hoa Binh, Vietnam, November 2017

Results of the project MAREX: Management of Mineral Resource Extraction in Hoa Binh Province – a Contribution to Sustainable Development in Vietnam (2015-2018)

Supported by BMBF, Grant Code FKZ 033R122A

Issue 4

Internet: www.marex-project.de

Editors
Dr.-Ing. Georg Schiller, Leibniz Institute of Ecological Urban and Regional Development, Dresden
Weberplatz 1 | 01217 Dresden, GERMANY | Phone: +49 351 4679 259 | Fax: +49 351 4679 212 |
E-Mail: g.schiller@ioer.de | Homepage: https://www.ioer.de

Dipl.-Ing. Tamara Bimesmeier, Leibniz Institute of Ecological Urban and Regional Development, Dresden
Weberplatz 1 | 01217 Dresden, GERMANY | Phone: +49 351 4679 209 | Fax: +49 351 4679 212 |
E-Mail: t.bimesmeier@ioer.de | Homepage: https://www.ioer.de

Prof. Dr. rer. nat. Petra Schneider, Hochschule Magdeburg-Stendal
Breitscheidstr. 2, Haus 6 | 39114 Magdeburg GERMANY | Phone: +49 391 886 4577 |
Fax: +49 391 886 4430 | E-Mail: petra.schneider@hs-magdeburg.de | Homepage: https://hs-magdeburg.de

Authors
Dipl.-Ing. Tamara Bimesmeier (Leibniz Institute of Ecological Urban and Regional Development, Dresden)
Pham Thi Viet Anh, PhD (VNU University of Science, Ha Noi)
Dipl.-Ing. Klaus Dieter Oswald (C&E Consulting und Engineering GmbH Chemnitz)
Dr.-Ing. Wolfgang Riedel (C&E Consulting und Engineering GmbH Chemnitz)
Dr.-Ing. Georg Schiller (Leibniz Institute of Ecological Urban and Regional Development, Dresden)
Prof. Dr. rer. nat. Petra Schneider (Hochschule Magdeburg-Stendal)

Design and Layout
Natalija Leutert

Editorial deadline August 2018

ISBN 978-3-933053-37-4

Cleaner production, mining optimizing approaches and material flow analysis

MAREX Workshop, Hoa Binh, Vietnam,
November 2017

Table of contents

Executive summary......1

Sustainable mining activities in Hoa Binh Province – the MAREX framework (Topic 1)

Georg Schiller: Sustainable mining activities in Hoa Binh Province – the MAREX framework......5

Basic information on methods and concepts (Topic 2)

Georg Schiller: Planning-oriented strategic Material Flow Analysis......23

Petra Schneider: Eco Efficiency, Life Cycle Assessment and Circular Economy......31

Planning-oriented strategic Material Flow Analysis (Topic 3)

Tamara Bimesmeier: Planning-oriented strategic MFA......45

Operational material flow management – Environmental Impact Assessment (Topic 4)

Pham Thi Viet Anh: Operational material flow management – Environmental Impact Assessment......75

Strategies towards efficient mining (Topic 5)

Petra Schneider: Artificial sand production......101

Wolfgang Riedel: Advanced mining technologies in open pit mines – drilling and blasting......115

Klaus-Dieter Oswald: Challenges and opportunities of aggregate mining in Hoa Binh Province – the engineering perspective......125

Conclusions and outlook......145

Executive summary

Georg Schiller, Tamara Bimesmeier, Petra Schneider

Due to economic development, population growth and rapid urbanization, Vietnam is currently experiencing an extraordinary building boom. This has led to an increased demand for construction materials. The capital region of Hanoi and the surrounding provinces constitutes one centre of this boom. Agricultural land and local natural resources are subject to a conflict of interest between various forms of use such as mining, nature conservation and settlement development.

One focus of the MAREX project is to examine the impacts of urban growth and construction activities in the Metropolitan Region of Hanoi, specifically the increasing demand for mined mineral building materials, taking Hoa Binh Province as an example. MAREX focuses on the extraction of mineral raw materials, primarily stones, clay and sand, for the construction industry. The project consists of four modules contributing to the main objective, namely to make mining more sustainable and to bring together responsible planning authorities and relevant stakeholders from the mining industry (*http://www.marex-project.de/*). On 1 & 2 November 2017, researchers from two of the four modules organized a planning seminar around the topic "Cleaner Production, Mining Optimizing and Material Flow". The seminar was held by experts working on material flow analysis at a regional scale as well as on Cleaner Production Technologies at the level of mining companies in Hoa Binh, Vietnam.

The theoretical background to the workshop was an assessment of the value chain *aggregate mining – transport – distribution – construction site – built environment*. The purpose and challenge of the seminar was to integrate research findings of the expert groups and to transfer knowledge at different planning scales to the mixed audience consisting of heads of mining companies, authorities and planners related to mining, regional planning, urban planning and construction planning.

The seminar program is shown in Table 1.

Table 1: Schedule of the MAREX seminar held in Hoa Binh City on 1 & 2 November 2017

Wednesday, 1 Nov 2017		Speaker
Opening Speech		Mr Müller (IOER), Mr Long (DoNRE)
Topic 1:	Sustainable mining activities in Hoa Binh Province – the MAREX framework	Mr Schiller (IOER)
Topic 2:	Basic information on methods and concepts	
Topic 2.1:	Planning-oriented strategic Material Flow Analysis	Mr Schiller (IOER)
Topic 2.2:	Eco Efficiency, Life Cycle Assessment and Circular Economy	Ms Schneider (HS Magdeburg)
Topic 3:	Planning-oriented strategic Material Flow Analysis	Ms Bimesmeier (IOER)
Thursday, 2 Nov 2017		**Speaker**
Topic 4:	**Operational material flow management** – Environmental Impact Assessment	Ms Viet Anh (IEA, Hanoi)
Topic 5:	**Strategies towards efficient mining**	
Topic 5.1:	Artificial sand production	Ms Schneider (HS Magdeburg)
Topic 5.2:	Advanced mining technologies in open pit mines – drilling and blasting	Mr Riedel (C&E)
Topic 5.3:	Challenges and opportunities of aggregate mining in Hoa Binh Province – the engineering perspective	Mr Oswald (C&E)

Figure 1: MAREX seminar in Hoa Binh City

After an introduction about the MAREX framework and applied methods (Topics 1 and 2), interim results were presented by the respective experts. The aim of Topics 1 and 2 was to convey how sustainable mining activities in Hoa Binh Province could be achieved in an integrated way. In the following discussion of Topics 3, 4 and 5, specific interim results were presented, starting with strategies at the regional level (Topic 3), through operational level strategies (Topic 4), to enterprise-level implementation proposals (Topic 5). The seminar served as a platform for interdisciplinary discussion and questions on each of the topics. The questions were raised by the experts as well as by the audience.

At the end of the two-day seminar, a final discussion round was initiated by Mr Georg Schiller in order to summarize and critically reflect on lessons learnt. Some conclusions were drawn both from the presentations and from the findings of the interim discussion rounds.

The audience was particularly interested in regional material flow calculations. Planners as well as representatives of the mining companies enriched the discussion about the assumptions underlying the calculation model. The objective of the upcoming research period will be to improve the model using the newly gained information and to strengthen the hypothetical framework behind the model.

Concerning activities at mining sites, it could be determined that the lack of efficiency is not due to technical barriers but rather to matters of management and regulation. Currently, mining sites in Vietnam are generally small in scale. The limited extraction volume per year and high competitive pressures have discouraged long-term investment. The mining companies stated that the small-scale mining approach is the most efficient way to deal with the current legal framework. Most companies are loath to make risky investments in order to increase productivity. It is unrealistic to expect small businesses to invest in technologies that are not yet regulated by law, as government support for their mining activities is thus not guaranteed. Nevertheless, there is great interest in new technologies such as in the production of artificial crushed sand. Hence, a first step towards more sustainable mining is to aim for closer collaboration between companies. This could be achieved, for example, by merging very small neighbouring businesses into larger enterprises or by creating associations to serve the interests of the mining companies, thereby influencing political decisions from the bottom up and promoting ideas to strengthen sustainable mining. Secondly, the master planning of mining, the granting of licences and the master planning of building materials should be designed for the long term and better integrated in order to encourage more sustainable mining. And, finally, mining activities can only be made safer and more environmentally friendly by the careful implementation of cleaner production technologies.

Figure 2: MAREX project team in Hoa Binh City, November 2017

Topic 1

Sustainable mining activities in Hoa Binh Province – the MAREX framework

Sustainable mining activities in Hoa Binh Province – the MAREX framework

Georg Schiller

The joint German-Vietnamese research project MAREX examines the environmental impacts of urban growth and construction activities in the Metropolitan Region of Hanoi and Hoa Binh Province. MAREX focuses on the extraction of mineral raw materials, primarily stones, clay and sand, for the construction industry.

National urbanization policies and related land use plans have boosted demand for construction materials, especially in fast growing metropolitan regions such as Hanoi. Since most of the required raw materials come from the surrounding provinces, local landscapes are changing dramatically. Air, water and soil are being contaminated by emissions and the farming sector is losing more and more fertile land.

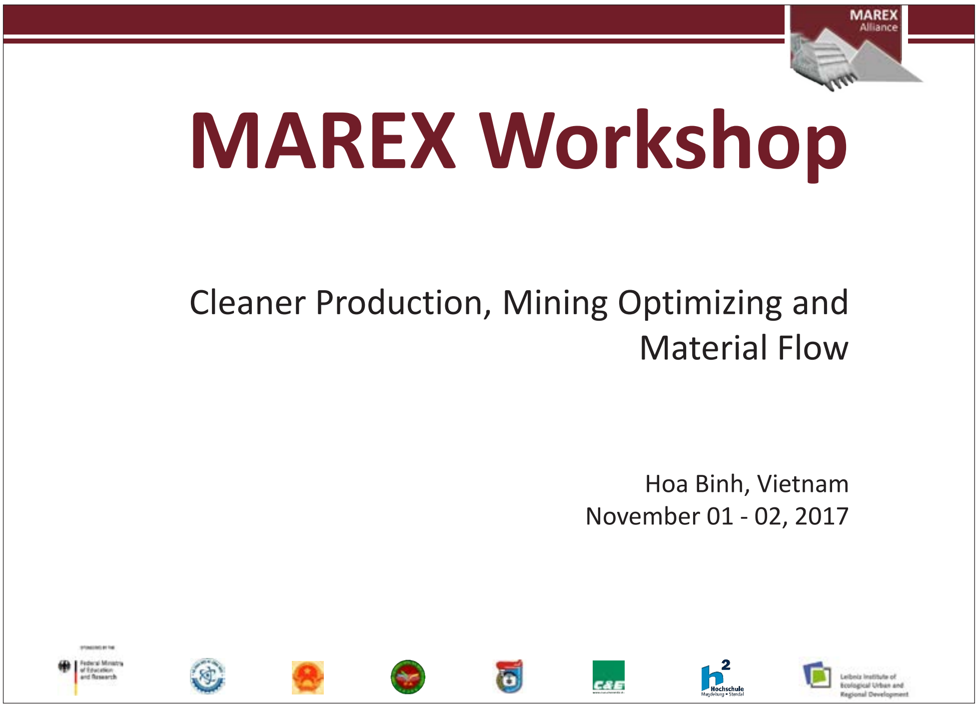
The scientific investigations of MAREX are carried out in the province of Hoa Binh, which borders Hanoi. An interdisciplinary approach aims to ensure sustainable development in Vietnam by improved management of the mining of mineral raw materials. The main goal is realised through four sub-objectives, which are associated with four project modules. These modules form the project structure. The first module is the development and implementation of software to facilitate the monitoring and evaluation of mining activities, including environmental impacts. The second goal is to promote the use of cleaner production principles and technologies in the mining industry as well as related capacity building for the planning of options to remediate polluted mining areas. Thirdly, the project focuses on the development of a tool for material flow analysis to support the quantitative estimation of expected demand for bulk building materials. The fourth sub-objective is to integrate all the tools developed within the other modules into a "business-policy interface" based on the concept of cooperative management and thereby bringing together the private sector (producers & customers) with regional planners and environmental authorities.

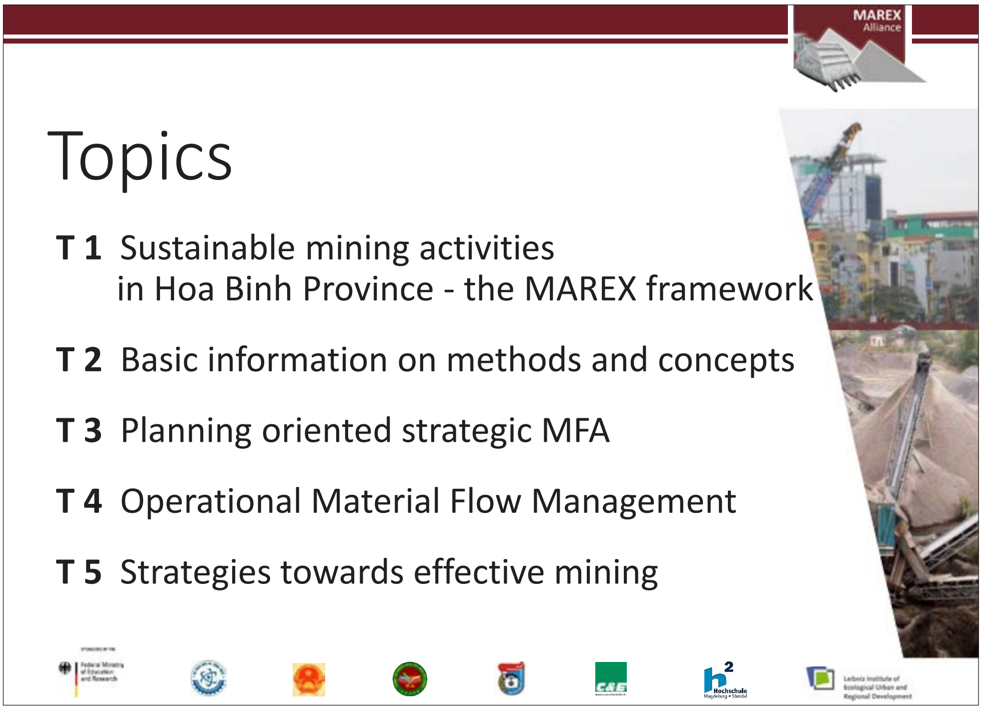
In the MAREX Seminar "Cleaner Production, Mining Optimizing and Material Flow" the main focus was on modules 2 and 3. These are closely linked by the common objectives of fostering discussion on future demand for building materials and the development of approaches to assess environmental issues. In short, the overall objective was to communicate knowledge on methods, concepts and mining technologies.

References

Müller, B. et al. (2016): Conference Documentation. Kick-off Conference 27/06/16-01/07/16. Management of Mineral Resource Extraction in Hoa Binh Province – A Contribution to Sustainable Development in Vietnam. In: Leibniz Institute of Ecological Urban and Regional Development. Dresden.

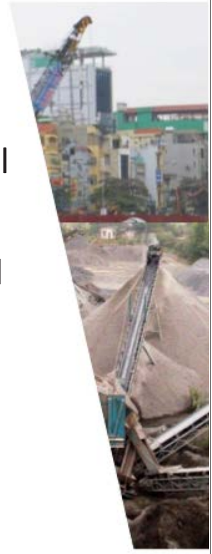
Bimesmeier, T.; Schiller, G. (2017): Planning-oriented Material Flow Analysis to support the management of mineral resources extraction in Vietnam. In Institute of Environment and Automation (IEA)/Leibniz Institute of Ecological Urban and Regional Development (IOER), Proceedings of the International Conference on Environment and Sustainable Development in Mineral Resource Extraction, Hanoi, Vietnam, 29-30 October 2017; Vietnam Academy of Science and Technology Press: Hanoi, Vietnam, 2017; pp. 167-177; ISBN 978-604-913-623-8.


MAREX
Alliance
MAREX Workshop
Cleaner Production, Mining Optimizing and Material Flow
Hoa Binh, Vietnam
November 01 - 02, 2017


MAREX
Alliance
Topics
T 1 Sustainable mining activities in Hoa Binh Province - the MAREX framework
T 2 Basic information on methods and concepts
T 3 Planning oriented strategic MFA
T 4 Operational Material Flow Management
T 5 Strategies towards effective mining

MAREX Alliance

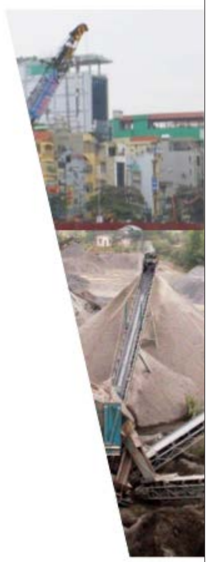
Objectives



1. Knowledge on methods and concepts (sustainable mining of mineral raw material for the construction industry)
2. Discuss future demand of building material
3. Approaches for environment oriented assessment
4. Knowledge about technology with regard to mining

MAREX Alliance

Participants

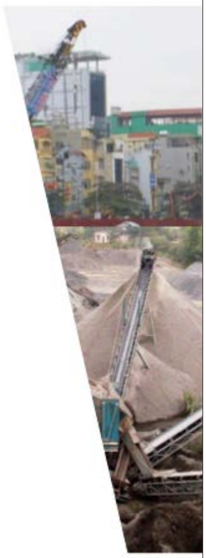


- Entrepreneurs of mining companies
- Planners
  - related to mining
  - related to regional planning and built environment

MAREX Alliance

Schedule

T 1	Sustainable mining activities in Hoa Binh Province - the MAREX framework	Wednesday morning I
T 2	Basic information on methods and concepts	Wednesday morning II
T 3	Planning oriented strategic MFA	Wednesday afternoon
T 4	Operational Material Flow Management	Thursday morning
T 5	Strategies towards efficient mining	Thursday afternoon



MAREX Alliance

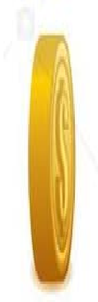
Sustainable mining activities in Hoa Binh Province – the MAREX framework

1. Background
2. About the MAREX Project
3. Work in Progress

Urban growth – Two sides of a coin

Urban Growth

- Population growth
- Land consumption
- Construction boom
- Need for food, water, energy, goods



Hinterland effects

- Provide food, water, energy, goods
- Change of land use
- Environmental and social impacts

The case of construction materials

Typical construction materials

- Concrete
- Bricks (clay, concrete)
- Asphalt
- Sand, gravel, crushed stone (= construction aggregates)
- Steel / other metals
- Glas

Sand, gravel, crushed stone

- Bulk material
- Low unit value
- High transport costs
- Low transport distances

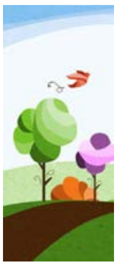
MAREX Alliance

Construction aggregates and the SUSTAINABLE DEVELOPMENT GOALS

Pictures: © www.un.org

MAREX Alliance

Viet Nam
National
Green
Growth Strategy



Viewpoints

- contribution to climate change strategy
- efficient use of natural capital
- using modern technologies
- …every level (government, ministries, localities, enterprises, social organizations

many links in terms of resource conservation, recycling, planning issues, etc.

Source: Socialist Republic of Vietnam, Sept 2012

Sustainable Development Goals (SDG)

- advancing economic growth
- reducing disparities in living standards and the creation of equal opportunities
- sustainable management of natural resources
- Emphasizing the importance of people in the development process
- strengthening of the regional and local dimension
- **implementation** of sustainable development into concrete activities

“**From ‘silo thinking’ towards an integrated approach**”

Source: side event at Rio +20, 19 Jun 2012

MAREX project (2015-18)

- Issue

Aggregates mining and its environmental, social and eco-nomic impacts

- Study Area

Vietnam

Hanoi City Region

Hoa Binh Province

- Objective

To improve the management of construction aggregates

- Partnership

4 German partners

Vietnamese research consortium

MAREX research foci

Where are the aggregates extracted? What are the impacts? → Spatial Monitoring

What technologies are used? How can they be improved? → **Cleaner Production**

What is the relation between demand and supply? → **Material Flows**

Who are the stakeholders? How can they collaborate in a better way? → Governance System

What are the impacts on regional development? → Regional Planning

The Challenge of MAREX project


© Schiller/IOER 2016

Drivers
- Economic growth
- Building boom

Pressure
- Rising demand for building materials

State
- Rapid increase of minerals extraction in the urban hinterland

Impact
- Landscape degradation, land use conflicts, pollution

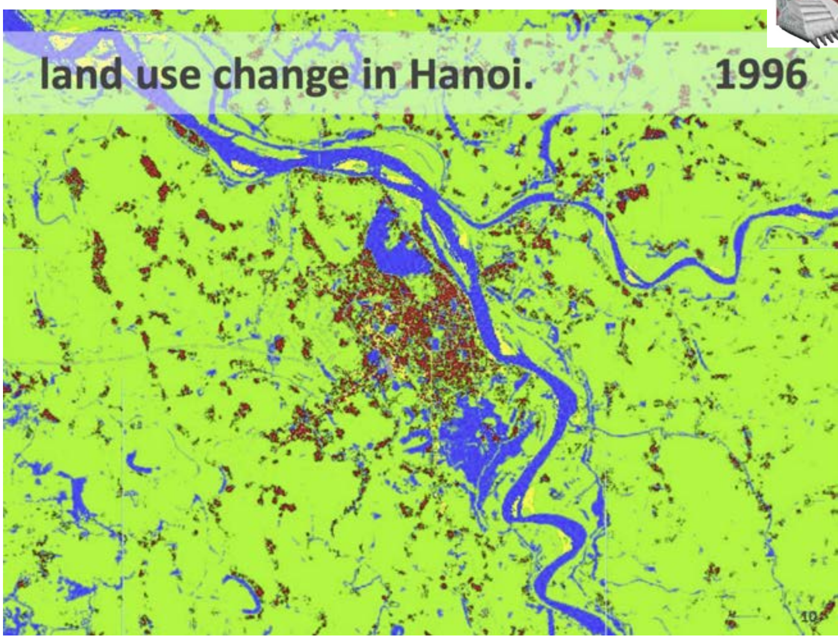
Response
- Policies, development strategies, implementation


© Schiller/IOER 2016

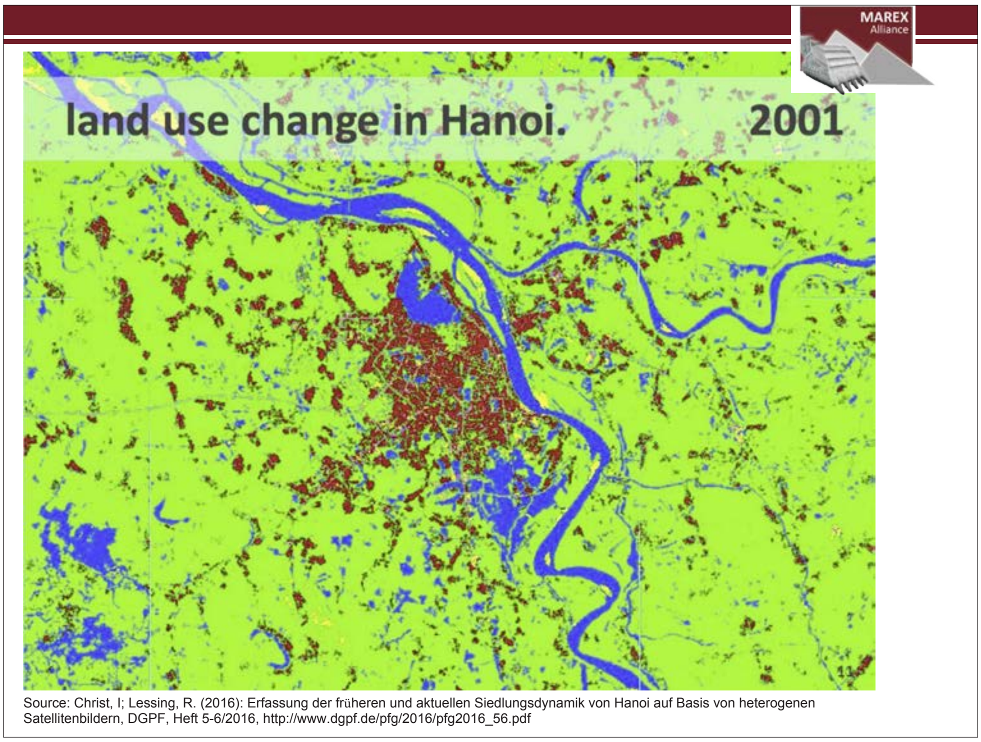
MAREX Alliance

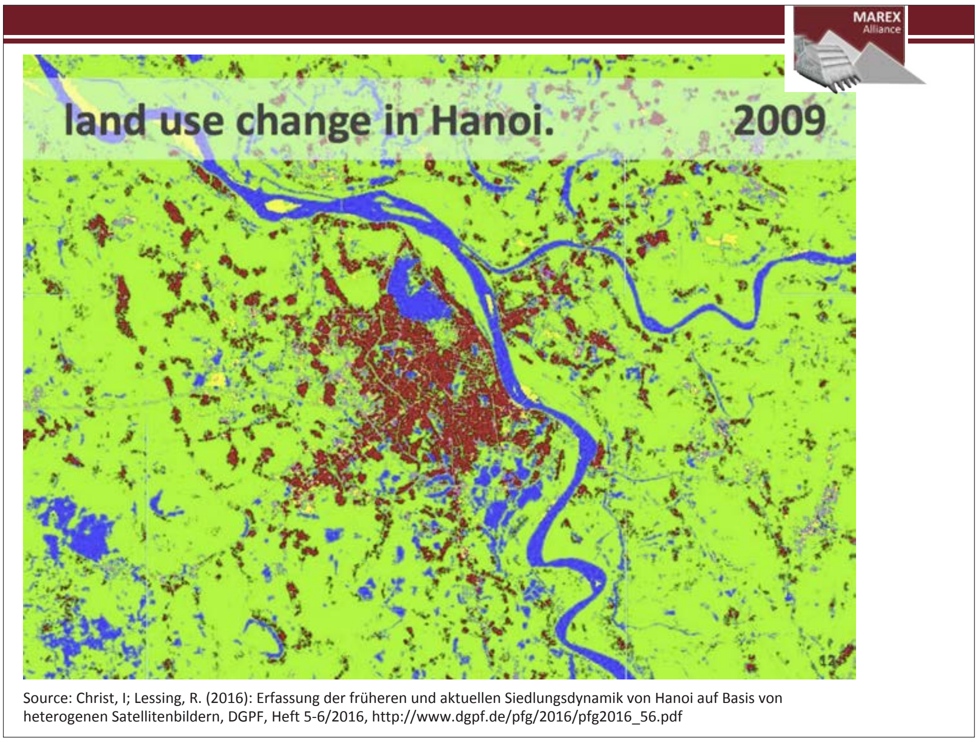
Study Area

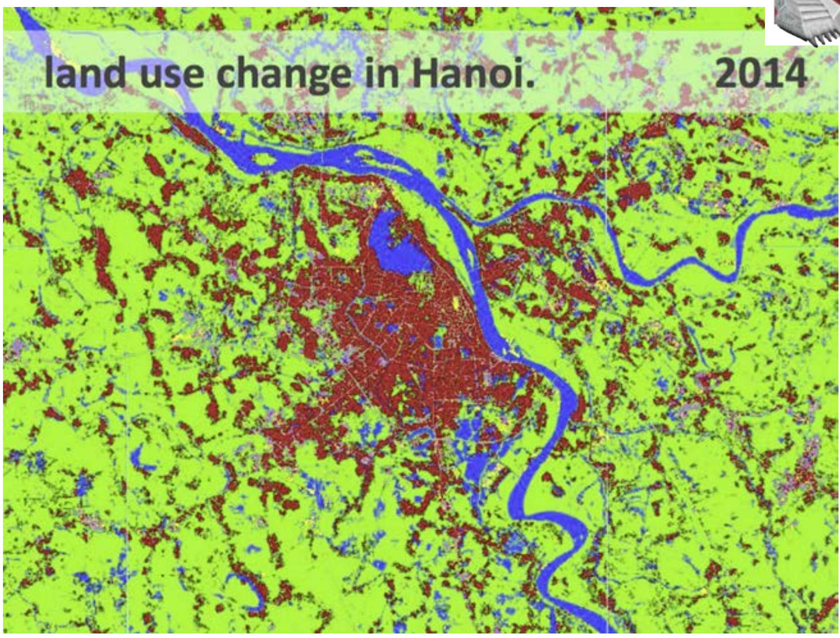
MAREX Alliance



Source: Christ, I; Lessing, R. (2016): Erfassung der früheren und aktuellen Siedlungsdynamik von Hanoi auf Basis von heterogenen Satellitenbildern, DGPF, Heft 5-6/2016, http://www.dgpf.de/pfg/2016/pfg2016_56.pdf

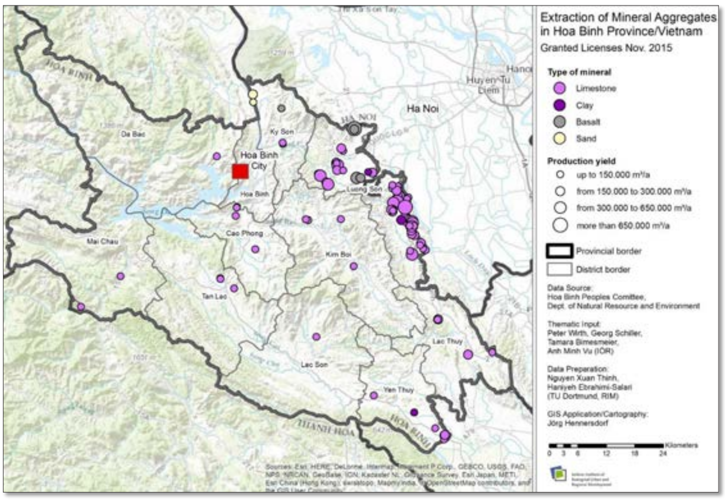

MAREX Alliance
land use change in Hanoi. 2001
Source: Christ, I; Lessing, R. (2016): Erfassung der früheren und aktuellen Siedlungsdynamik von Hanoi auf Basis von heterogenen Satellitenbildern, DGPF, Heft 5-6/2016, http://www.dgpf.de/pfg/2016/pfg2016_56.pdf


MAREX Alliance
land use change in Hanoi. 2009
Source: Christ, I; Lessing, R. (2016): Erfassung der früheren und aktuellen Siedlungsdynamik von Hanoi auf Basis von heterogenen Satellitenbildern, DGPF, Heft 5-6/2016, http://www.dgpf.de/pfg/2016/pfg2016_56.pdf



Source: Christ, I; Lessing, R. (2016): Erfassung der früheren und aktuellen Siedlungsdynamik von Hanoi auf Basis von heterogenen Satellitenbildern, DGPF, Heft 5-6/2016, http://www.dgpf.de/pfg/2016/pfg2016_56.pdf

Aggregates extraction in Hoa Binh



Mining Site – Luong Son District

Source: Google Maps 2017

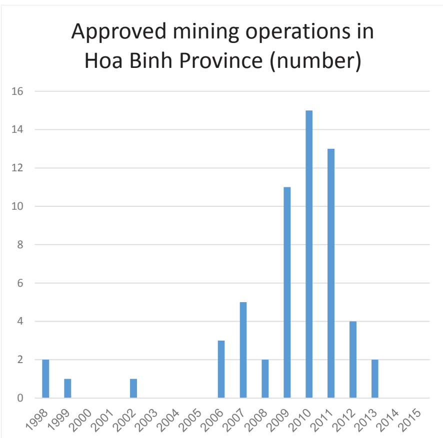
Environmental impacts

- Landscape
  - Damage of scenic places
- Biodiversity
  - Habitat & biodiversity loss
- Water (surface and ground)
  - Contamination (turbidity)
  - Changes in flow rates
- Soil
  - Degradation, fertility loss
  - Wind and water erosion
- Air
  - Dust and noise emission
- Vibration

Land Use Conflicts

- Natural Protection
- Agriculture
- Residential areas
- Tourism

Licensing of aggregates mining

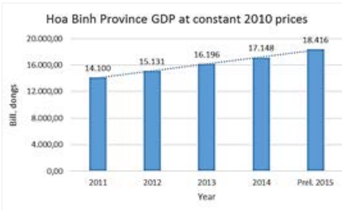


Data Source: DoNRE
Chart: Wirth/IOER

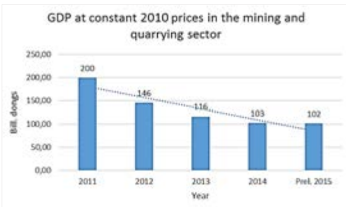
- Until 2005 state responsibility for licensing
- Assumption: Artisanal mining (unlicensed)
- 2005 New Minerals Law (Decentralisation)
- Since 2006 hype of granting licenses
- Since 2011 oversupply

MAREX Alliance

Importance of Aggregate Mining in Hoa Binh Regional Economy



- Strong economic growth in provincial economy …% annual averige



- Economic recession in the quarrying sector

Data Source: Hoa Binh Statistical Yearbook 2015
Charts: Wirth/IOER

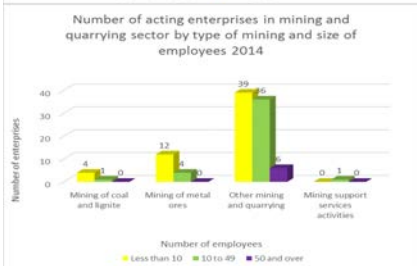
MAREX Alliance

Importance of Aggregate Mining in Regional Economy

In the mining sector aggregates are dominating

BUT

Only small and medium sized companies (exepted cement factories)



Data Source: Hoa Binh Statistical Yearbook 2015
Charts: Wirth/IOER

Expected Products and Impacts of the MARX project

Products **(Outputs)**

- Monitoring Software
- Technical Guideline
- MFA Forecast Tool
- Business-Policy Interface

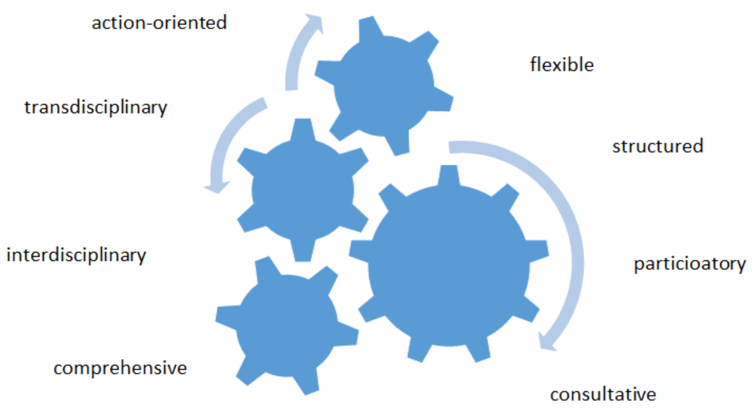
Impacts **(Outcomes)**

- Knowledge gain
- Support learning processes
- Behaviour change of actors
- Fostering **integrated planning**

Contribute to the „best of all possible worlds“

(*Gottfried Wilhelm Leibniz 1710*)

Integrated planning




MAREX
Alliance
Integrated Regional, Land-use, Construction planning
© Schiller/IOER 2016
© Schiller/IOER 2016
Waste management
Capacity planning mining
Building material production
Settlement planning
Infrastructure planning
Green Building
Circular economy

Topic 2

Basic information on methods and concepts

Planning-oriented strategic Material Flow Analysis

Georg Schiller

The presentation aimed to give some basic information on applied methods and concepts in order to discuss the future demand for building materials and to develop approaches for assessing environmental issues. The chosen method to estimate future demand for building materials is material flow analysis (MFA). Life cycle assessment, environmental impact assessment as well as cleaner production technologies are used to develop approaches for assessing environmental issues. The focus of the presentation was to define and explain MFA, which is an analytical method to describe metabolisms by quantifying material flows, material stocks and changes to these in a defined system considering a specific subject and various spatial or temporal scales.

The sustainable, application-oriented and long-term planning of mining activities largely depends on the quality of information on the expected demand for those materials. Dynamic material flow analysis (MFA) is a helpful tool to analyse the material stock in the built environment as well as the annual demand for raw materials. There are two basic approaches: A top-down method, which aims to find correlations between economic data, population development and consumption patterns; and a bottom-up method, which aims to analyse the elements of the built environment in detail in order to quantify and qualify material stocks and flows. The latter approach is particularly useful for creating a decision-making basis since it not only provides valuable information on the quantity of the required materials but also on the required qualities (Schneider et al. 2018).

References

Schneider, P.; Klaus-Dieter Oswald, K.-D.; Riedel, W.; Meyer, A.; Schiller, G.; Bimesmeier, T.; Viet Anh Pham Thi; Long Nguyen Khac (2018): Engineering Perspectives and Environmental Life Cycle Optimization to Enhance Aggregate Mining in Vietnam. Sustainability. 10. 525. 10.3390/su10020525.

MAREX Alliance

MAREX Workshop

Basic information on methods and concepts

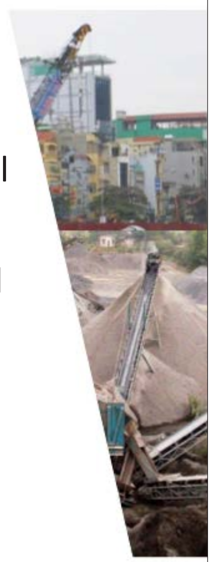
Hoa Binh, Vietnam
November 01 - 02, 2017

1

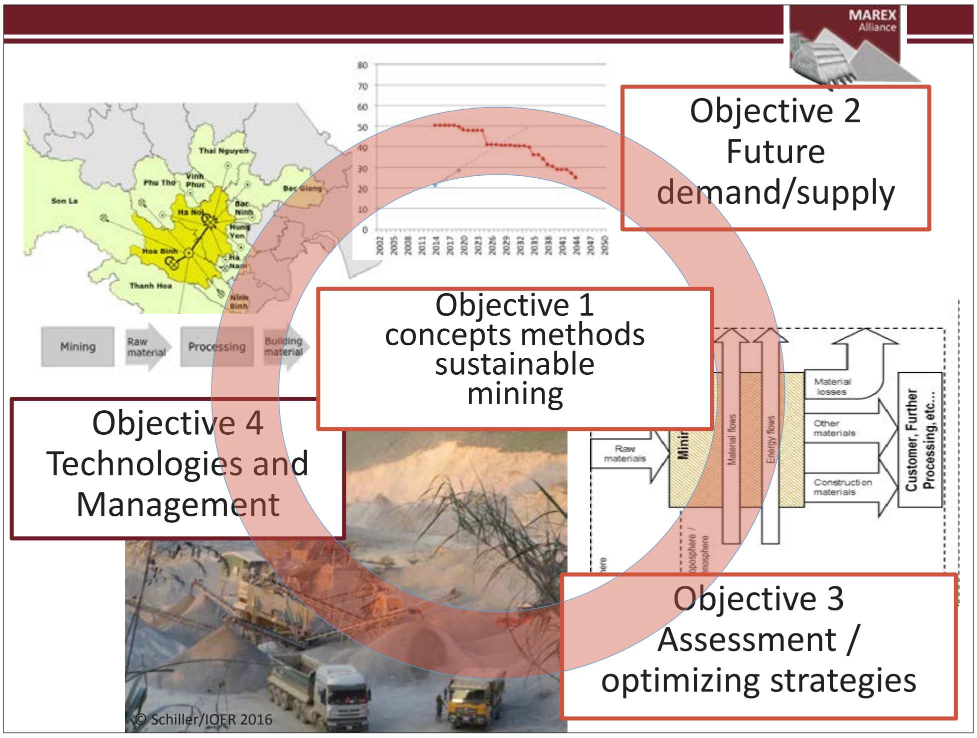
MAREX Alliance

Objectives

1. Knowledge on methods and concepts (sustainable mining of mineral raw material for the construction industry)
2. Discuss future demand of building material
3. Approaches for environment oriented assessment
4. Knowledge about technology with regard to mining

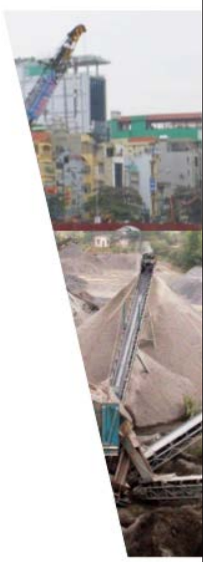


2



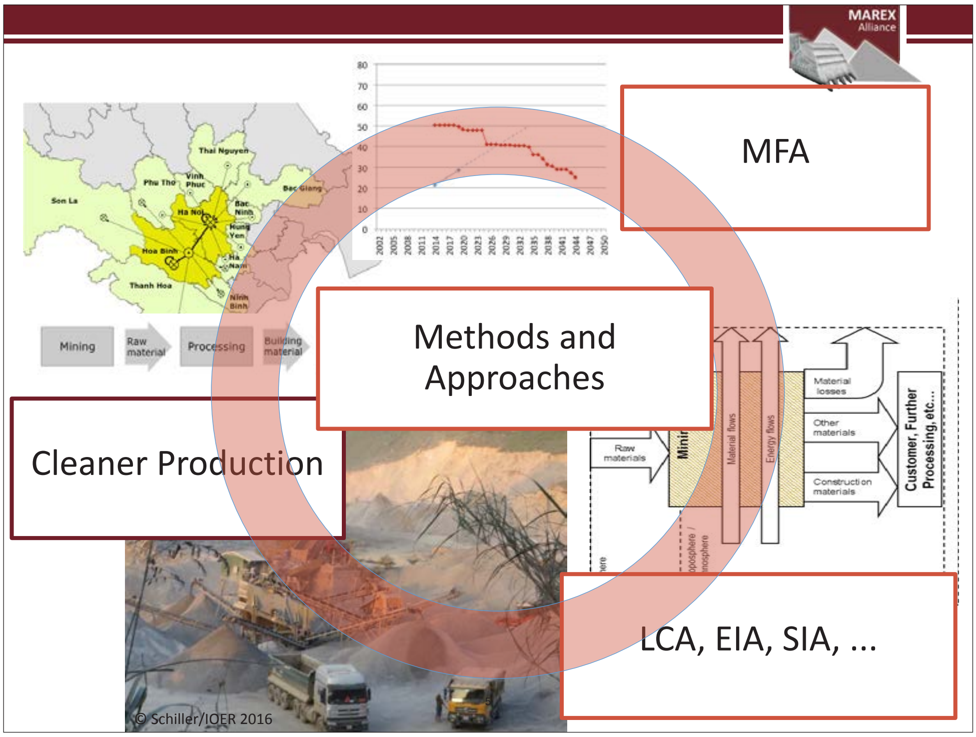
MAREX Alliance

Schedule



T 1	Sustainable mining activities in Hoa Binh Province - the MAREX framework	Wednesday morning I
T 2	Basic information on methods and concepts	Wednesday morning II
T 3	Planning oriented strategic MFA	Wednesday afternoon
T 4	Operational Material Flow Management	Thursday morning
T 5	Strategies towards efficient mining	Thursday afternoon

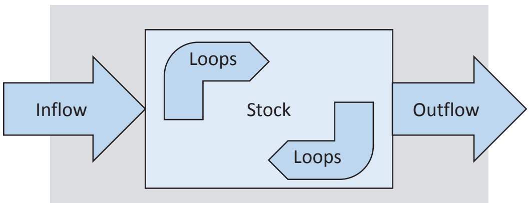
4



MAREX
Alliance

MFA = Material Flow Analysis

- analytical method to describe metabolisms
  by quantifying material flows, material stocks and stock changes
  in a defined system



- considering a specific **subject** and **spatial** and **temporal** scales

6

MFA Methods

Top down

overall economic data (flows)
- economic environmental accounts, external trade, trade associations' data, waste statistics, …
- metric, monetary, mass

differentiation
- flow characteristics (in-, output, flow-through)
- groups of goods / sectors / materials

conversion
- conversion from metric dimensions into mass

deduction

material amount
- flows, accumulated flows

+ complete

- limits of differentiation

7

Top down

population

x

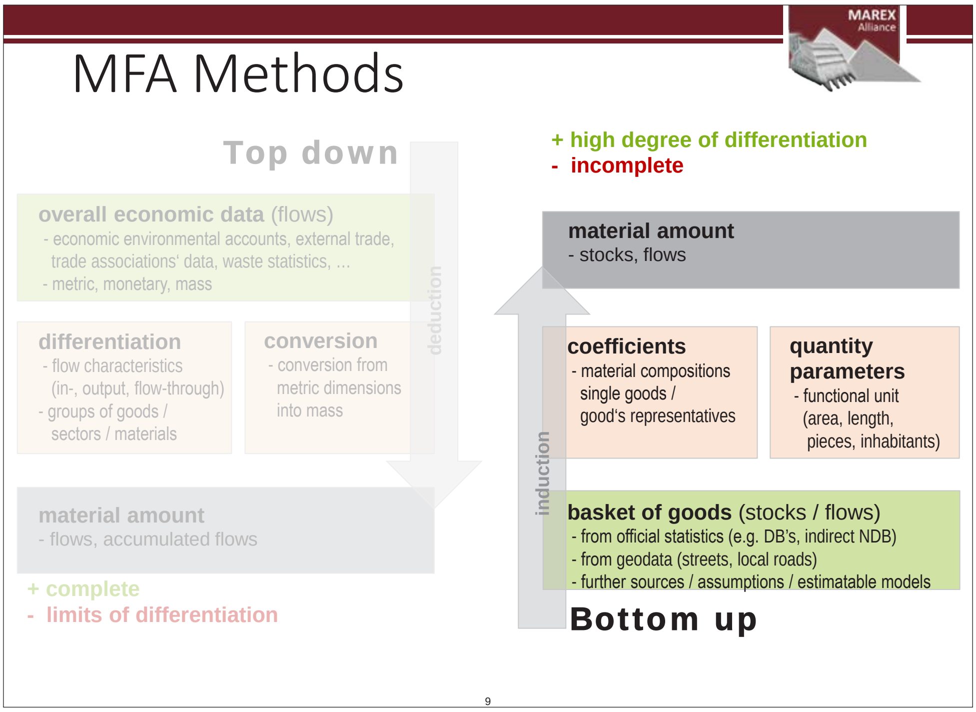
consumption per person

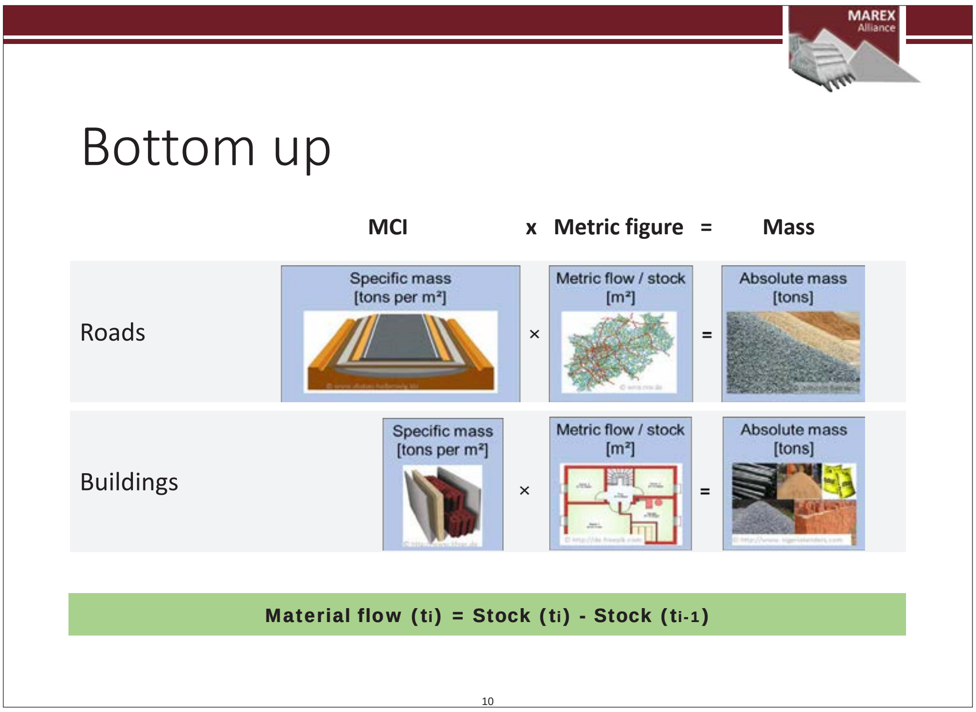
economic figures

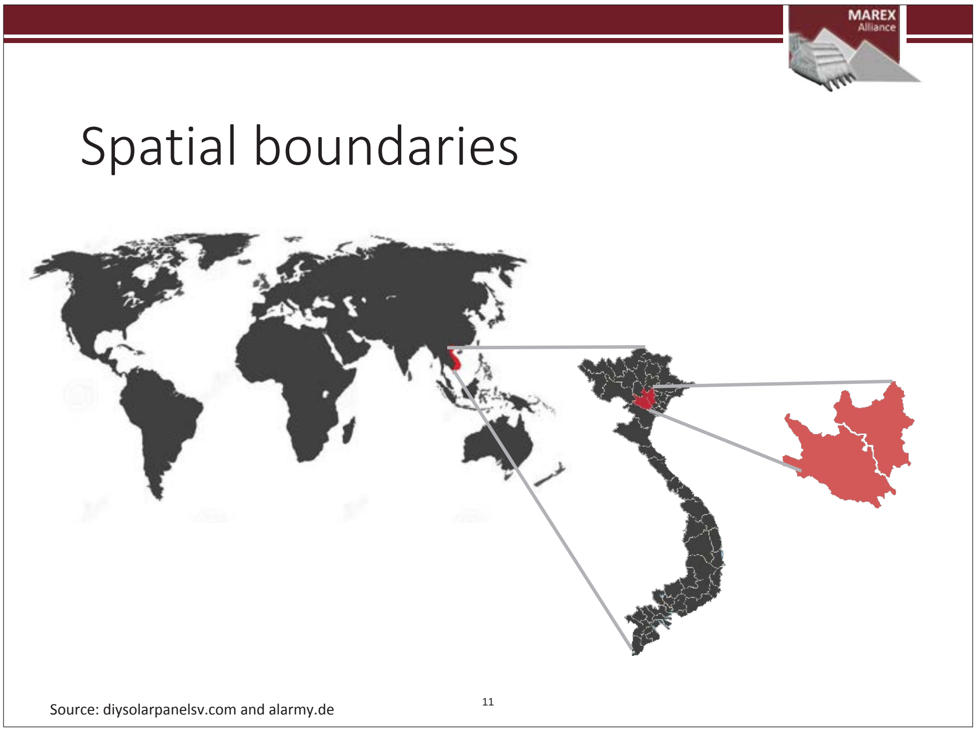
← →

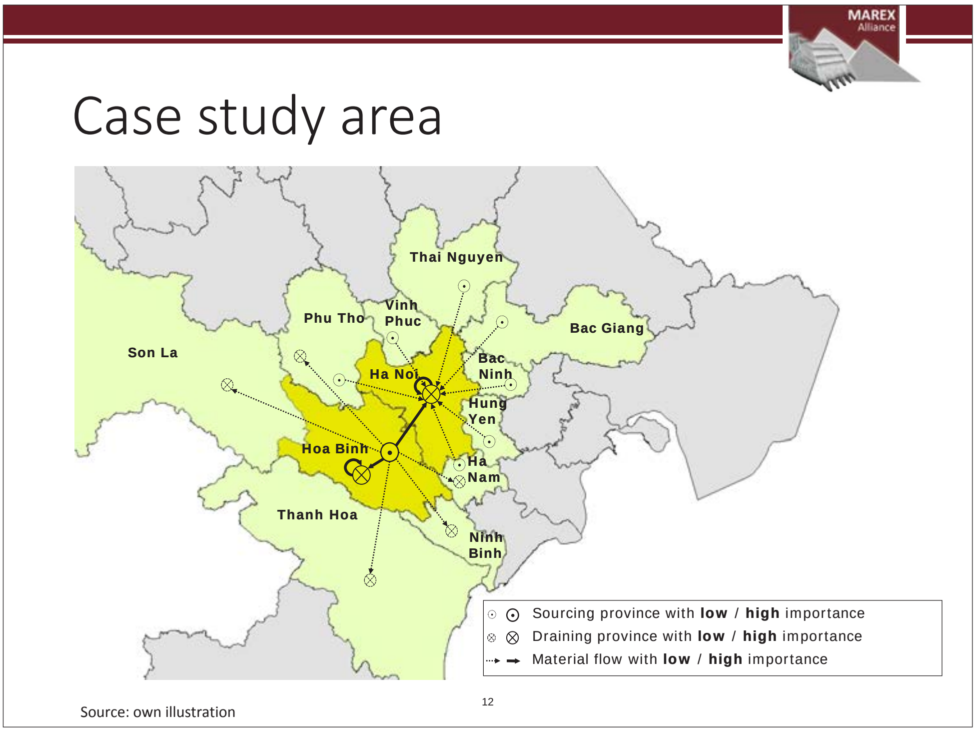
consumption per person

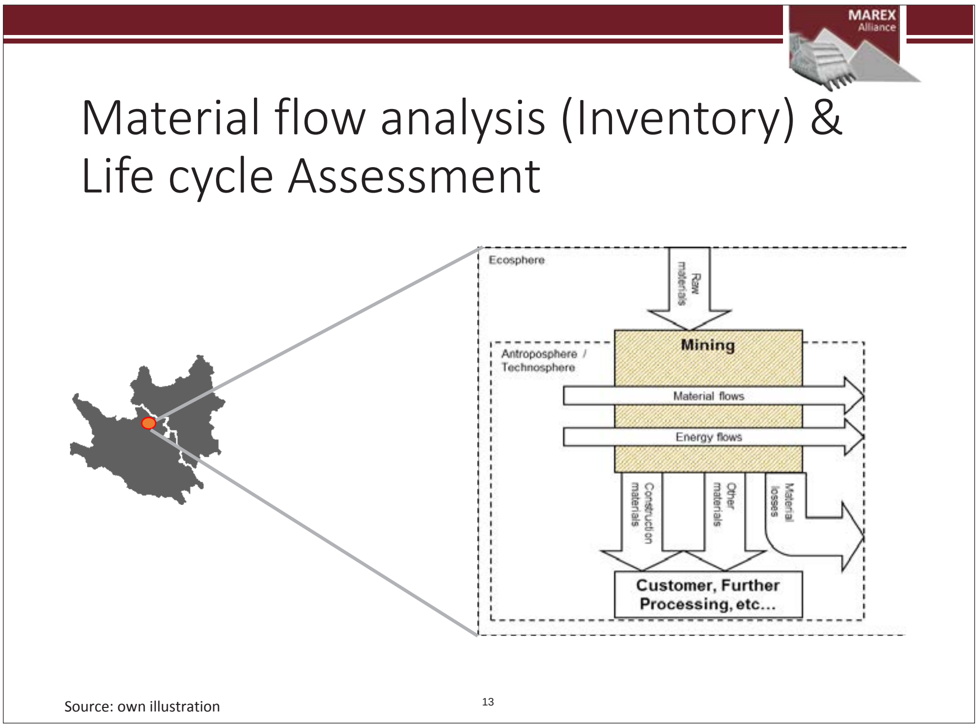
8


MAREX Alliance
MFA Methods
Top down
overall economic data (flows)
- economic environmental accounts, external trade, trade associations' data, waste statistics, ...
- metric, monetary, mass
differentiation
- flow characteristics (in-, output, flow-through)
- groups of goods / sectors / materials
conversion
- conversion from metric dimensions into mass
deduction
material amount
- flows, accumulated flows
+ complete
- limits of differentiation
+ high degree of differentiation
- incomplete
material amount
- stocks, flows
coefficients
- material compositions single goods / good's representatives
quantity parameters
- functional unit (area, length, pieces, inhabitants)
induction
basket of goods (stocks / flows)
- from official statistics (e.g. DB's, indirect NDB)
- from geodata (streets, local roads)
- further sources / assumptions / estimatable models
Bottom up
9


MAREX Alliance
Bottom up
MCI x Metric figure = Mass
Roads
Specific mass [tons per m²]
×
Metric flow / stock [m²]
=
Absolute mass [tons]
Buildings
Specific mass [tons per m²]
×
Metric flow / stock [m²]
=
Absolute mass [tons]
Material flow (ti) = Stock (ti) - Stock (ti-1)
10


MAREX
Alliance
Spatial boundaries
Source: diysolarpanelsv.com and alarmy.de
11


MAREX
Alliance
Case study area
Thai Nguyen
Vinh
Phuc
Phu Tho
Bac Giang
Son La
Bac
Ninh
Ha Noi
Hung
Yen
Hoa Binh
Ha
Nam
Thanh Hoa
Ninh
Binh
Sourcing province with low / high importance
Draining province with low / high importance
Material flow with low / high importance
Source: own illustration
12


MAREX
Alliance
Material flow analysis (Inventory) &
Life cycle Assessment
Ecosphere
Raw materials
Mining
Antroposphere / Technosphere
Material flows
Energy flows
Construction materials
Other materials
Material losses
Customer, Further Processing, etc...
Source: own illustration
13

Eco Efficiency, Life Cycle Assessment and Circular Economy

Petra Schneider

In order to improve aggregate mining, we need feasible approaches to environmental assessment along the value chain *aggregate mining – transport – distribution – construction site – building* as well as utilisation of the Cleaner Production (CP) potential. CP is a philosophy for environmental protection in the production and services sector introduced by the United Nations under the United Nations Environment Program (UNEP). It encompasses the entire production-integrated environmental protection of a process chain, regardless of the sector concerned (UNEP 2006). At the level of strategic company positioning, Cleaner Production is considered vital for the development of the circular economy. The overall scope of the assessment is to find potentials for environmental optimization in order to achieve a cradle-to-cradle system (Braungart & McDonough 2002).

The formulation of Cleaner Production Concepts (CPC) derives from the 1992 Conference on Environment and Development in Rio de Janeiro. The basis of CPC is the idea of a sustainable, integrated and systematic environmental protection strategy that focuses equally on processes, products and services. However, the background is not only environmental protection, but also the idea of sustainability in order to achieve a reduction of ecological risks under positive economic and social aspects while avoiding negative production processes. CP is an important method at the level of strategic company positioning for the development of cycle management and includes measures for product- and production-integrated environmental protection. Eco-efficiency (or "economic-ecological efficiency") plays a key role in the implementation of appropriate measures. It is defined as the ratio between the added value of production against the negative environmental impacts (Schaltegger et. al. 2007). A suitable tool for determining the environmental impacts associated with eco-efficiency is the Life Cycle Analysis (LCA) according to DIN ISO 14040: 2006. LCA is a procedure for the collection and assessment of environmentally relevant processes.

In the framework of CP, resource productivity is the environmentally-friendly approach to production, aiming to increase the productivity of resources and thereby reduce waste. This implies the better utilization of resources. In the mining sector, resource productivity can be improved through activities to increase the extraction of raw materials from deposits as well as the additional use of secondary minerals and fractions. In analogy to eco-efficiency, socio-efficiency is the ratio between the added value and the social damage, whereby the social damage corresponds to the sum of all negative social effects of a product, process or activity.

References

Braungart, M.; McDonough, W. (2002): Cradle to Cradle. Remaking the Way We Make Things; North Point Press: New York, NY, USA.

Schaltegger, S.; Herzig, C.; Kleiber, O.; Klinke, T.; Müller, J. (2007): Nachhaltigkeitsmanagement in Unternehmen – Von der Idee zur Praxis: Managementansätze zur Umsetzung von Corporate Social Resposibility und Corporate Sustainability. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit: Bonn, Germany; ISBN 978-3-935630-60-3.

UNEP – United Nations Environment Programme (2006): Environmental Agreements and Cleaner Production – Questions and Answers; Frequently Asked Questions: Applying Cleaner Production to Facilitate the Implementation of Multilateral Environmental Agreements. United Nations Environment Programme; Division of Technology, Industry & Economics, In: Cooperation with InWEnt: Paris, France; ISBN 92-807-2717-6.

MAREX Alliance

MAREX Workshop

Background Terms and Definitions

A contribution by the Vietnamese-German MAREX Project
November 01-02 2017 • Hoa Binh city • Vietnam

MAREX Alliance

Main topics

- Eco Efficiency and value chain as base for Life Cycle Assessment
- Socio efficiency and sustainability, circular economy, cradle-to-cradle

Subtopics

- Concept of Sustainability and the Way to Circular Economy
- Approach to the Transformation of a Value Chain into a Value Circle
- Eco-Design, Eco-Labeling, Eco-innovation, Eco-efficiency and Cleaner Production

MAREX Alliance

Turning a Value Chain into a Value Circle

Turning a Value Chain into a Value Circle

MAREX Alliance

Concept of value chain (Michael Porter, 1985)

Rather than looking at departments or accounting cost types, Porter's Value Chain focuses on systems, and how inputs are changed into the outputs purchased by consumers. Using this viewpoint, Porter described a chain of activities common to all businesses, and he divided them into primary and support activities, as shown below.

Source: [Michael Porter, 1985]

Turning a Value Chain into a Value Circle

Inbound logistics – These are all the processes related to receiving, storing, and distributing inputs internally. Your supplier relationships are a key factor in creating value here

Operations – These are the transformation activities that change inputs into outputs that are sold to customers. Here, your operational systems create value.

Source: [Michael Porter, 1985]

Outbound logistics – These activities deliver your product or service to your customer. These are things like collection, storage, and distribution systems, and they may be internal or external to your organization.

Marketing and sales – These are the processes you use to persuade clients to purchase from you instead of your competitors. The benefits you offer, and how well you communicate them, are sources of value here

Service – These are the activities related to maintaining the value of your product or service to your customers, once it's been purchased

Turning a Value Chain into a Value Circle

Porter value chain for mining

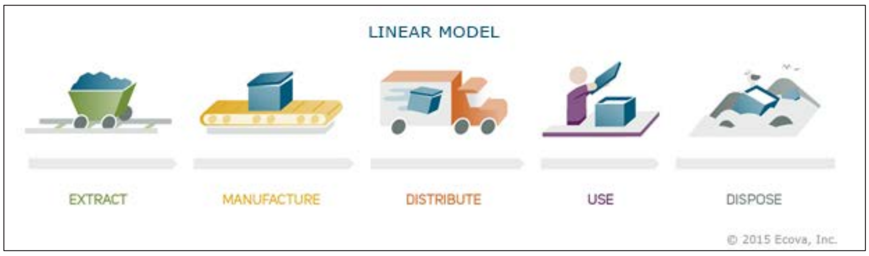
		Primary activities									
	Michael Porter model	Inbound logistics			Operations			Outbound logistics	Marketing and sales	Service	Margin
	Mining value chain	Locate	Valuate	Establish	Mine	Transport	Beneficiate	Marketing		Divest	
Supporting activities	Mineral resource management Financial management Procurement / logistics Asset / maintenance management Research and development Human resource management Risk management Information systems										

Source: [The Journal of the South African Institute of Miniung and Metallurgy]

Turning a Value Chain into a Value Circle

Linear economic models reach their limits

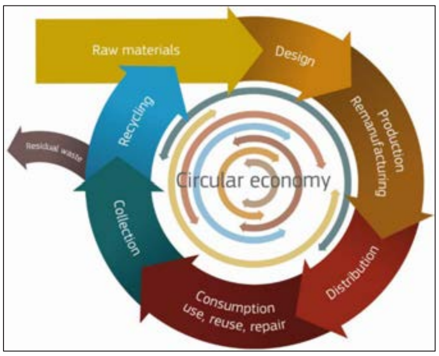
- classic linear economic models are reaching their limits.
- scarce resources cause pressure to the value chains
- A way of solution: Cradle to Cradle® having biological and technical cycle.



Turninga Value Chain into a Value Circle

Circular economic models

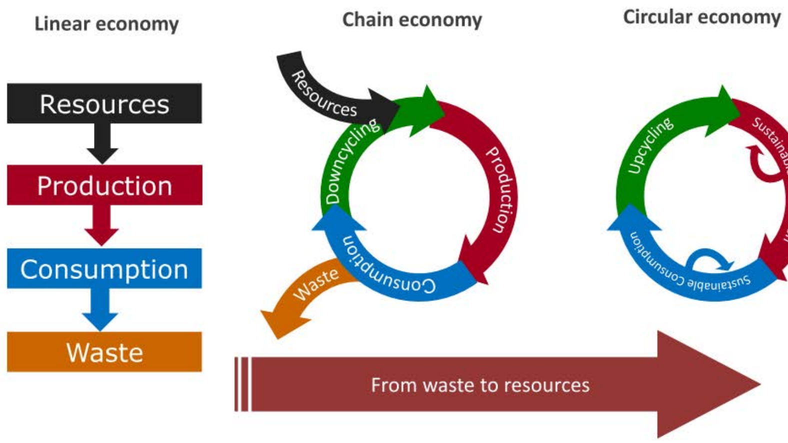
- A circular economyis restorative and regenerative by design,
- aims to keep products, components, and materials at their highest utility and value at all times.



Source: [EASME, 2018]

Turning a Value Chain into a Value Circle

Circular economic models

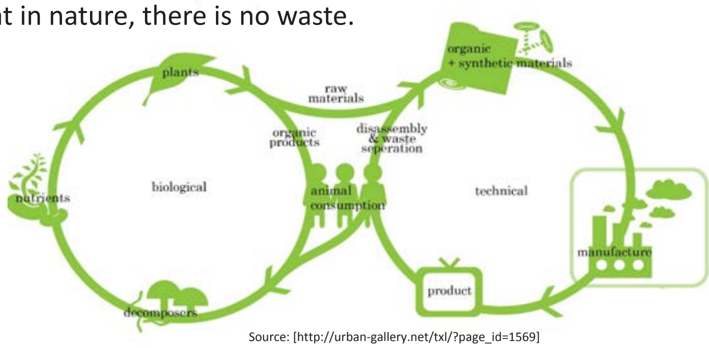


Source: [http://trinomics.eu/project/technological-innovations-and-financial-instruments-for-a-circular-economy/]

Turning a Value Chain into a Value Circle

Cradle-to-Cradle

C2C is used to describe a sustainability model which is imitative of natural processes, with the goal of enriching and benefiting the environment even as products are manufactured and used. The underlying principle of this concept is that in nature, there is no waste.



Source: [http://urban-gallery.net/txl/?page_id=1569]

Turning a Value Chain into a Value Circle

MAREX Alliance

Resource efficiency is the maximising of the supply of money, materials, staff, and other assets that can be drawn on by a person or organization in order to function effectively, with minimum wasted (natural) resource expenses.

Source: [http://jpovaska.com]

Turning a Value Chain into a Value Circle

MAREX Alliance

Resource productivity

the process of using resources as effectively as possible when producing goods and services in order to reduce or avoid waste:

Incentives will be offered for care and conservation, efficiency, and resource productivity.

Source: [isb-global.com]

Turning a Value Chain into a Value Circle

Industrial Symbiosis

Further development of the cradle-to-cradle concept

not only to close material cycles inside a company, but also between different companies.

- Common use (sharing) of energy sources
- Common re-use of wastes
- Common use (sharing) of equipment

Eco-Design, Eco-Labeling, Eco-innovation, Eco-efficiency and Cleaner Production

Eco-Design and Eco-Labeling

MAREX Alliance

Eco-Design

“the integration of environmental aspects into product design and development, with the aim of reducing adverse environmental impacts throughout a product's life cycle” (ISO 14006)

Source: [https://www.umweltbundesamt.de/themen/wirtschaft-konsum/produkte/oekodesign]

Eco-Design and Eco-Labeling

MAREX Alliance

Eco-Design

Eco design is a systematic and comprehensive design approach for products to reduce environmental impacts over the entire life cycle.

In the product planning and design phase, producers can influence every phase of value creation and the material life path and promote ecological innovations.

Source: [https://www.youtube.com/watch?v=R5pJ57EOseQ]

Eco-Design and Eco-Labeling

MAREX Alliance

Eco-innovatoin

Eco-innovation is about reducing our environmental impact and making better use of resources.

This means developing products, techniques, services and processes that reduce CO_2 emissions, use resources efficiently, promote recycling and so on. There are five main strands to this initiative:

- Materials recycling and recycling processes;
- Sustainable building products;
- Food and drink sector;
- Water efficiency, treatment and distribution;
- Greening business.

Eco-Design and Eco-Labeling

MAREX Alliance

Eco label

"Ecolabelling" is a voluntary method of environmental performance certification and labelling that is practised around the world.

An ecolabel identifies products or services proven environmentally preferable overall, within a specific product or service category.

An eco label can support and facilitate the environmental reporting to the authorities.

An eco label can be used as marketing instrument.

Source: [https://www.dreamstime.com/stock-images-green-eco-label-pure-nature-sign-white-background-image34599514]

Eco-Design and Eco-Labeling

MAREX Alliance

EU Ecolabel

Established in 1992, the EU Ecolabel is a third party certified Type I ISO 14024 aimed to promote products and services which have a reduced environmental impact helping European consumers distinguish environmentally friendly products.

Source: [http://www.alamy.com/stock-photo/green-energy-eco-friendly-badge.html]

Sources

MAREX Alliance

[1] Giljum, Stefan et.al.: Overconsumption? Our use of the world´s natural resources. Heidenreichstein, 2009
[2] https://www.eea.europa.eu/soer-2015/global/competition
[3] https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept
[4] Jacobus A. Du Pisani: Sustainable development – historical roots of the concept. Environmental Sciences, 2017. P. 83-96
[5] UNIDO: GLOBAL VALUE CHAINS, DEVELOPMENT AND EMERGING ECONOMIES. Vienna, 2015
[6] EUROPEAN COMMISSION: Product Environmental Footprint (PEF) Guide. Ispra, 2012
[7] http://ec.europa.eu/environment/ecolabel/facts-and-figures.html
[8] United Nations Environment Programme UNEP (2006): Environmental Agreements and Cleaner Pro-duction - Questions and Answers, Frequently Asked Questions: Applying Cleaner Production to Facili-tate the Implementation of Multilateral Environmental Agreements, UN Environment Program, Division of Technology, Industry & Economics, In co-operation with InWEnt, ISBN: 92-807-2717-6.

Source: [foe.co.uk]

Topic 3

Planning-oriented strategic Material Flow Analysis

Planning oriented strategic MFA

Tamara Bimesmeier

The main focus of the presentation was on the explanation of a planning-oriented strategic material flow analysis (MFA) model. The aim of the model is to better forecast the demand for mineral building materials, to deliver reliable figures for decision-making and subsequently to foster more sustainable long-term mining and land use planning. In an opening section, the chosen MFA approach was presented, followed by an illustration of the supply situation of mineral building materials in Hoa Binh Province. After comparing demand figures reported in master plans, top-down demand estimates and differentiated long-term bottom-up calculations as well as relations between supply and demand figures were expounded. The presentation finished with a discussion of conclusions and open questions.

Material flow analysis can only be conducted by defining temporal, spatial and physical system boundaries. In the MAREX project, retrospective as well as prospective analyses are envisaged within the metropolitan area of Hanoi and Hoa Binh Province. Supply relations to surrounding provinces are considered but not analysed in detail. The examined elements are limited to roads and buildings, as these are the main consumers of mineral building materials. The developed MFA model within the MAREX project is based on a bottom-up approach. The main advantage of bottom-up calculations is that a detailed and comprehensible calculation basis is formed by an intelligently chosen set of input parameters. The variation of certain input parameters allows not only a discussion of likely development trends, but also an analysis of sensitivities. In regard to buildings and roads, standard input parameters are the length of the road network, the available and required per capita floor area as well as material compositions of typical roads and buildings.

One of the main findings is the huge gap between registered quantities of available materials and the calculated demand from construction activities in Hanoi and Hoa Binh Province. Finally, the potential reasons for this gap were discussed as well as repercussions for the environment and the economy.

References

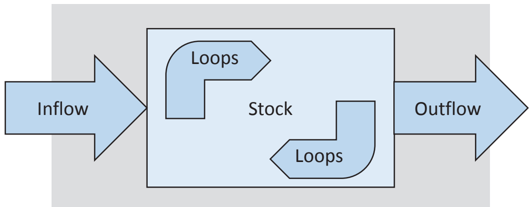
Bimesmeier, T.; Schiller, G. (2017): Planning-oriented Material Flow Analysis to support the management of mineral resources extraction in Vietnam. In Institute of Environment and Automation (IEA)/Leibniz Institute of Ecological Urban and Regional Development (IOER), Proceedings of the International Conference on Environment and Sustainable Development in Mineral Resource Extraction, Hanoi, Vietnam, 29-30 October 2017; Vietnam Academy of Science and Technology Press: Hanoi, Vietnam, 2017; pp. 167-177, ISBN 978-604-913-623-8.


MAREX
Alliance
MAREX
Workshop
Planning-oriented Material Flow Analysis
to support the management of mineral
resources extraction in Vietnam
Georg Schiller, Tamara Bimesmeier
Hoa Binh, Vietnam
November 01 - 02, 2017
1


MAREX
Alliance
MAREX
Workshop
Planning-oriented Material Flow Analysis
to support the management of mineral
resources extraction in Vietnam
Georg Schiller, Tamara Bimesmeier
Hoa Binh, Vietnam
November 01 - 02, 2017
2

MFA = Material Flow Analysis

- analytical method to describe metabolisms by quantifying **material flows**, material **stocks** and stock **changes** in a **defined system**



- considering a specific **subject** and **spatial** and **temporal** scales

3

MAREX Workshop

Planning-oriented Material Flow Analysis to support the management of mineral resources extraction in Vietnam

Georg Schiller, Tamara Bimesmeier

Hoa Binh, Vietnam
November 01 - 02, 2017

4

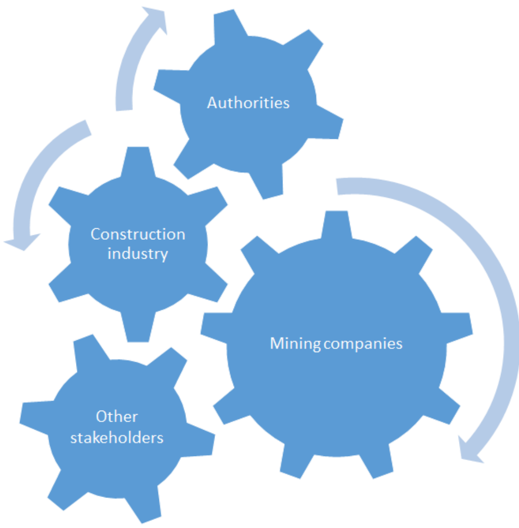
Planning-oriented

- Support of planning tasks
  - Mining Planning
  - Regional Planning
  - Settlement Planning, …
- Related to a specific area
- Involvement of stakeholders

5

Integrated planning

Involvement of stakeholders



MAREX Alliance

MAREX Workshop

Planning-oriented Material Flow Analysis
to support the management of mineral resources extraction in Vietnam

Georg Schiller, Tamara Bimesmeier

Hoa Binh, Vietnam
November 01 - 02, 2017

7

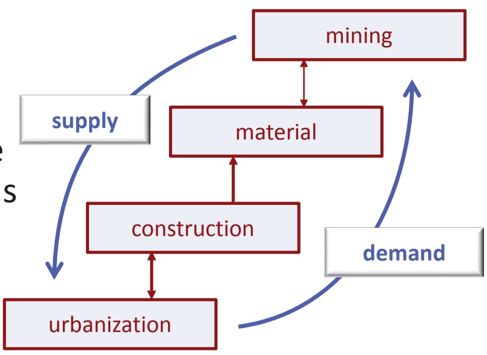
MAREX Alliance

How to support?

- Quantifying supply and demand of building material in Hoa Binh Province & Hanoi

→ harmonization of both by planning

→ creation of reliable figures for decisions



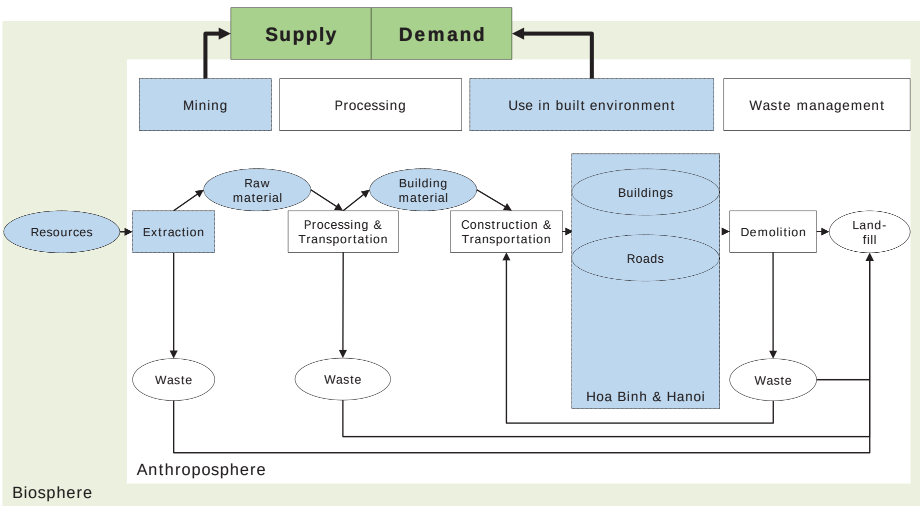
8

Outlook

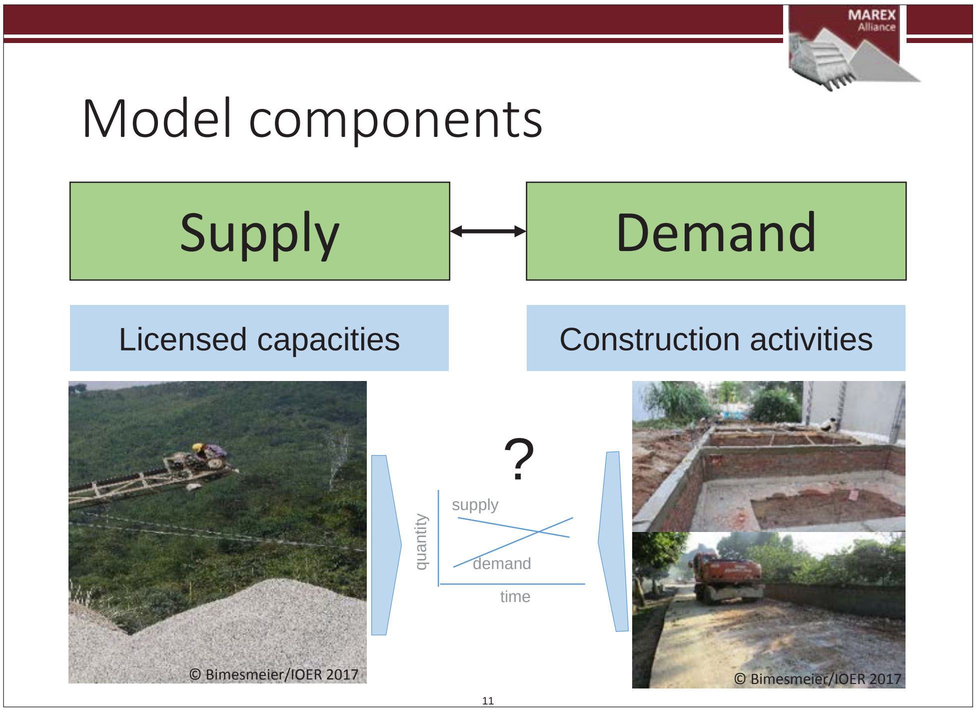
- **MFA – Approach**
- Supply
  - licensed capacities
- Demand
  - figures reported in master plans
  - long-term estimation (top down)
  - differentiated long-term calculation (bottom up)
- Supply – demand relation
- Conclusion

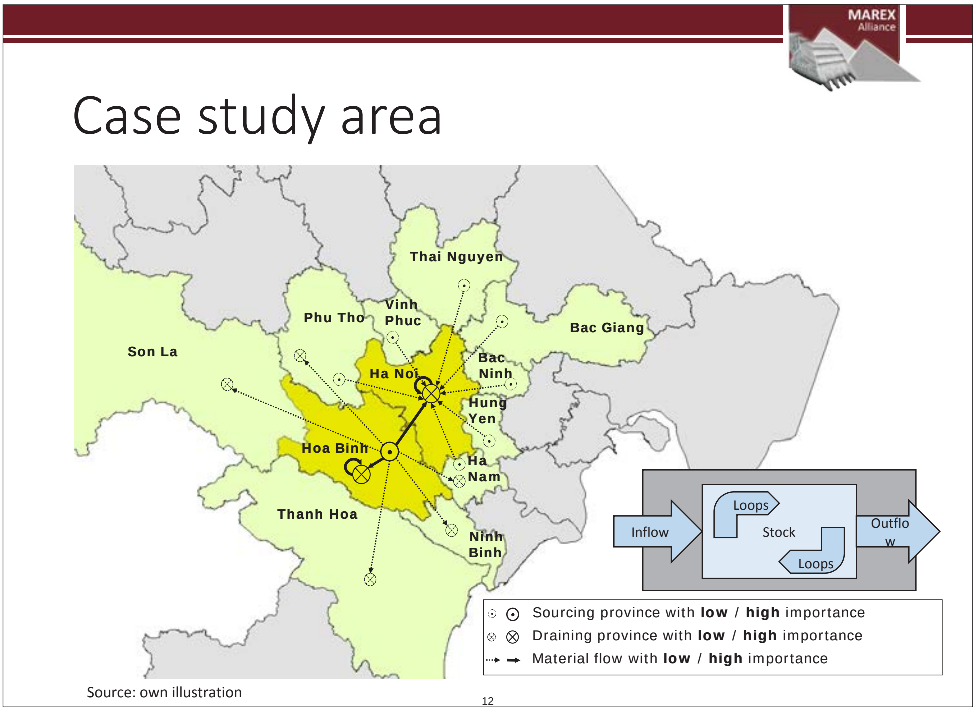
9

Focus of MFA in MAREX



10


MAREX Alliance
Model components
Supply
Demand
Licensed capacities
Construction activities
?
supply
quantity
demand
time
© Bimesmeier/IOER 2017
© Bimesmeier/IOER 2017
11


MAREX Alliance
Case study area
Thai Nguyen
Vinh Phuc
Phu Tho
Bac Giang
Son La
Bac Ninh
Ha Noi
Hung Yen
Hoa Binh
Ha Nam
Thanh Hoa
Ninh Binh
Inflow
Loops
Stock
Loops
Outflow
Sourcing province with low / high importance
Draining province with low / high importance
Material flow with low / high importance
Source: own illustration
12

Outlook

- MFA – Approach
- **Supply**
  - **- licensed capacities**
- Demand
  - - figures reported in master plans
  - - long-term estimation (top down)
  - - differentiated long-term calculation (bottom up)
- Supply – demand relation
- Conclusion

13

Register of legal Mining businesses

Hoa Binh Province (state 2015)

#	Date of approval	License No.	Name of business	License period (years)	Type of mineral	Mine reserve (t)	Max. annual output (t)	Operating area (ha)	Site location - commune	Licensing agency
1	1998-12-14	x	x	30	clay	720.000	24.000	4	Xã Yên Trị	MoNRE
2	1998-12-14	x	x	30	limestone	2.550.000	85.000	3,7	Xã Ngọc Lương	MoNRE
3	1999-06-18	x	x	22	limestone	11.263.854	552.227	16	Xã Tân Vinh	People's Committee HB
4	2002-05-20	x	x	23	limestone	4.699.800	287.210	11	Xã Thành Lập	People's Committee HB
x	...	...	...	...	...	...	...	...	...	...

14

Register of legal Mining businesses

Hoa Binh Province (state 2015)

#	Date of approval	License No.	Name of business	License period (years)	Type of mineral	Mine reserve (t)	Max. annual output (t)	Operating area (ha)	Site location - commune	Licensing agency
1	1998-12-14	x	x	30	clay	720.000	24.000	4	Xã Yên Trị	MoNRE
2	1998-12-14	x	x	30	limestone	2.550.000	85.000	3,7	Xã Ngọc Lương	MoNRE
3	1999-06-18	x	x	22	limestone	11.263.854	552.227	16	Xã Tân Vinh	People's Committee HB
4	2002-05-20	x	x	23	limestone	4.699.800	287.210	11	Xã Thành Lập	People's Committee HB
x	...	...	...	...	...	...	...	...	...	...

15

Licensed mine reserves – annual capacities

$$\boxed{\text{Annual capacities (tons/year)}} = \sum_{i=1}^{n} \frac{\boxed{\text{Licensed mine reserve}_i \text{ (tons)}}}{\boxed{\text{Licence period}_i \text{ (years)}}}$$

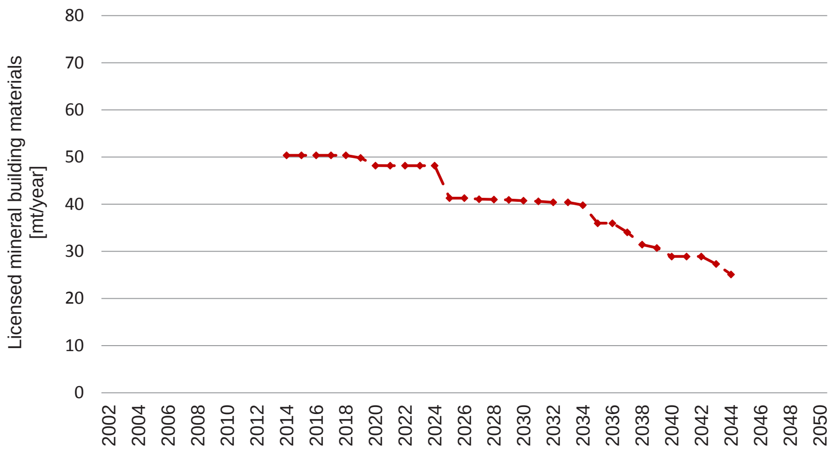
i = license no.

Assumptions:
- consdering all licensed capacities in reference year 2015
- no additional licenses in the future

16

MAREX Alliance

Licensed Capacities (Supply)
Hoa Binh Province (state 2015)



17

MAREX Alliance

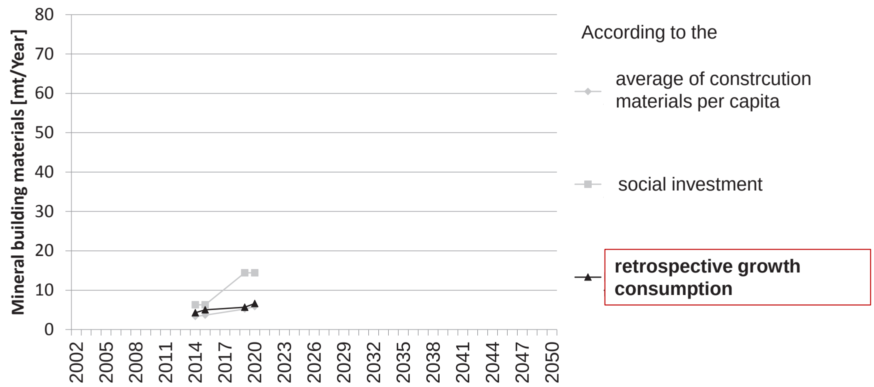
Outlook

- MFA – Approach
- Supply
  - licensed capacities
- **Demand**
  - **figures reported in master plans**
  - long-term estimation (top down)
  - differentiated long-term calculation (bottom up)
- Supply – demand relation
- Conclusion

18

Mining Masterplan [1]

Short-term demand calculation for Hoa Binh

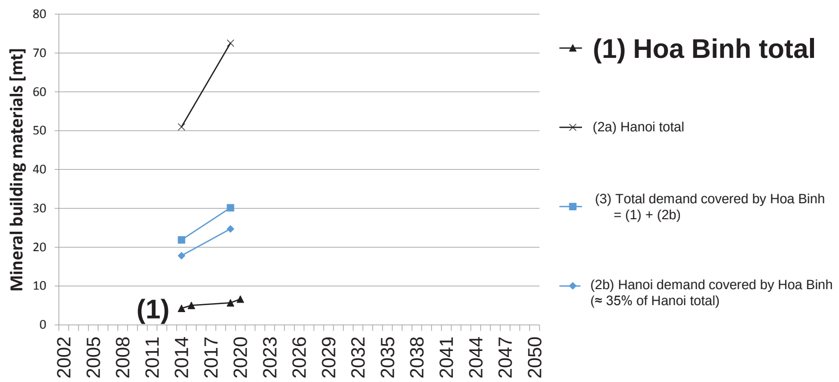


[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials: **Stones** and **sand** for construction materials, **clay for bricks** in Hoa Binh province, period 2014-2019, with a vision to 2024", p.42 ff

19

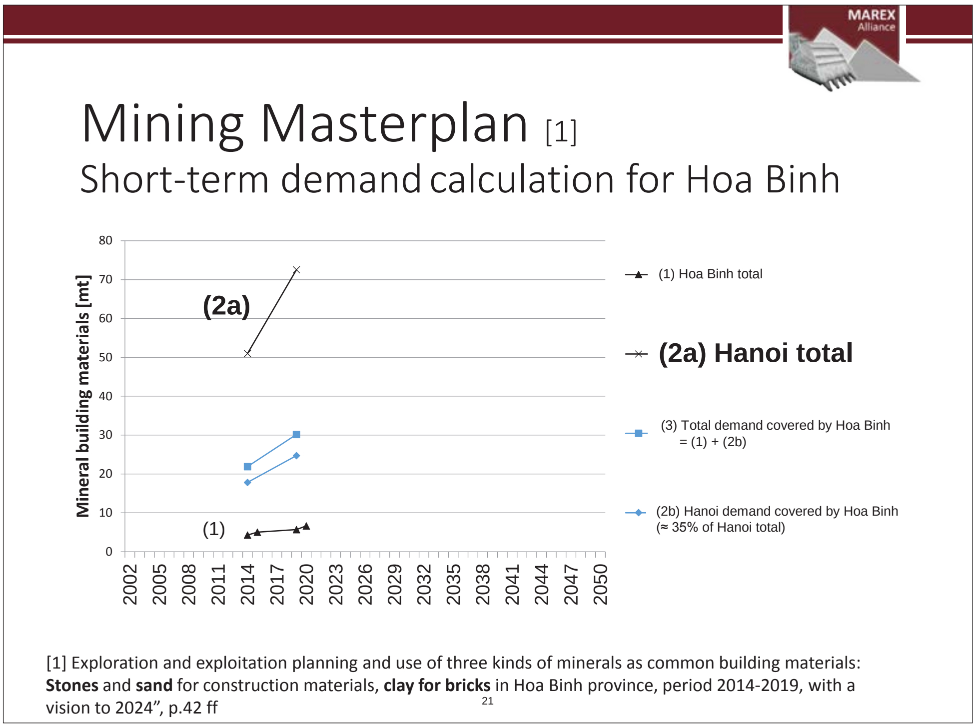
Mining Masterplan [1]

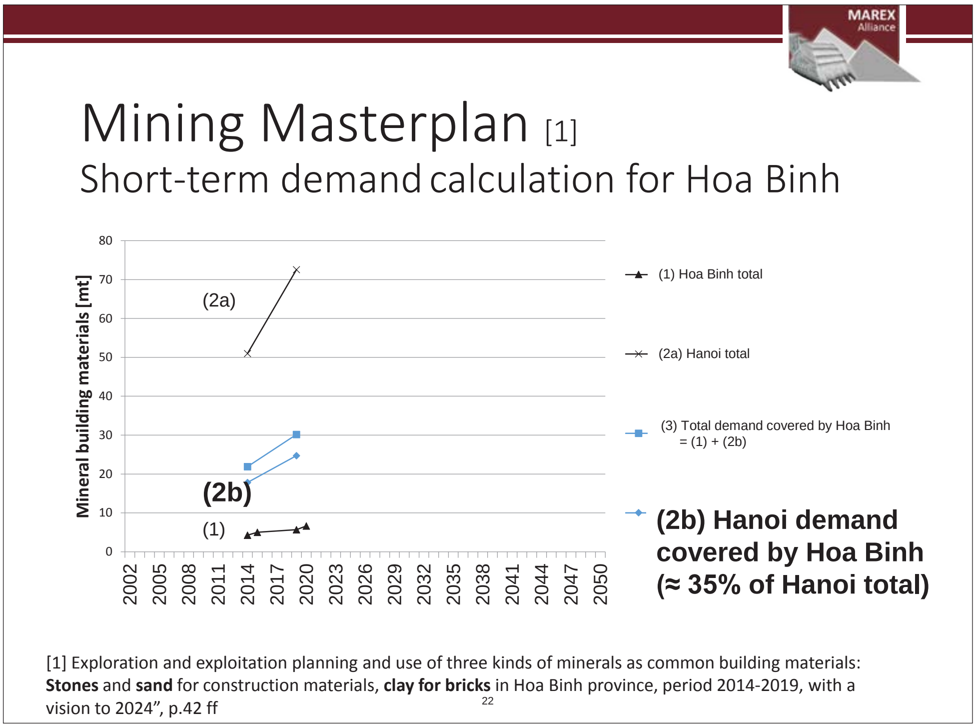
Short-term demand calculation for Hoa Binh



[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials: **Stones** and **sand** for construction materials, **clay for bricks** in Hoa Binh province, period 2014-2019, with a vision to 2024", p.42 ff

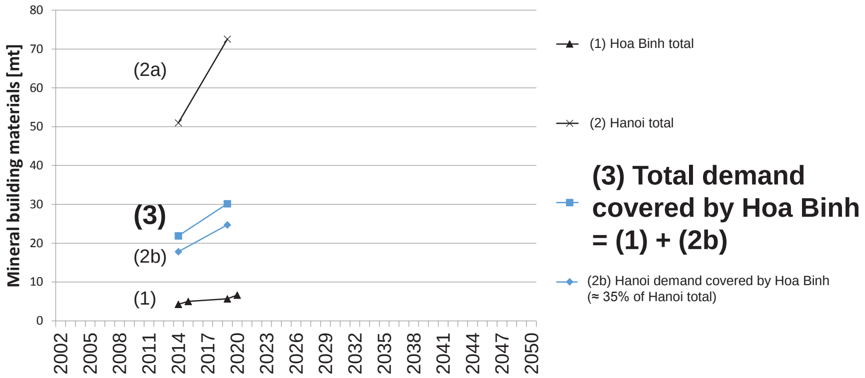
20


MAREX Alliance
Mining Masterplan [1]
Short-term demand calculation for Hoa Binh
Mineral building materials [mt]
80
70
60
50
40
30
20
10
0
2002 2005 2008 2011 2014 2017 2020 2023 2026 2029 2032 2035 2038 2041 2044 2047 2050
(2a)
(1)
(1) Hoa Binh total
(2a) Hanoi total
(3) Total demand covered by Hoa Binh = (1) + (2b)
(2b) Hanoi demand covered by Hoa Binh (≈ 35% of Hanoi total)
[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials: **Stones** and **sand** for construction materials, **clay for bricks** in Hoa Binh province, period 2014-2019, with a vision to 2024", p.42 ff
21


MAREX Alliance
Mining Masterplan [1]
Short-term demand calculation for Hoa Binh
Mineral building materials [mt]
80
70
60
50
40
30
20
10
0
2002 2005 2008 2011 2014 2017 2020 2023 2026 2029 2032 2035 2038 2041 2044 2047 2050
(2a)
(2b)
(1)
(1) Hoa Binh total
(2a) Hanoi total
(3) Total demand covered by Hoa Binh = (1) + (2b)
(2b) Hanoi demand covered by Hoa Binh (≈ 35% of Hanoi total)
[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials: **Stones** and **sand** for construction materials, **clay for bricks** in Hoa Binh province, period 2014-2019, with a vision to 2024", p.42 ff
22

Mining Masterplan [1]

Short-term demand calculation for Hoa Binh



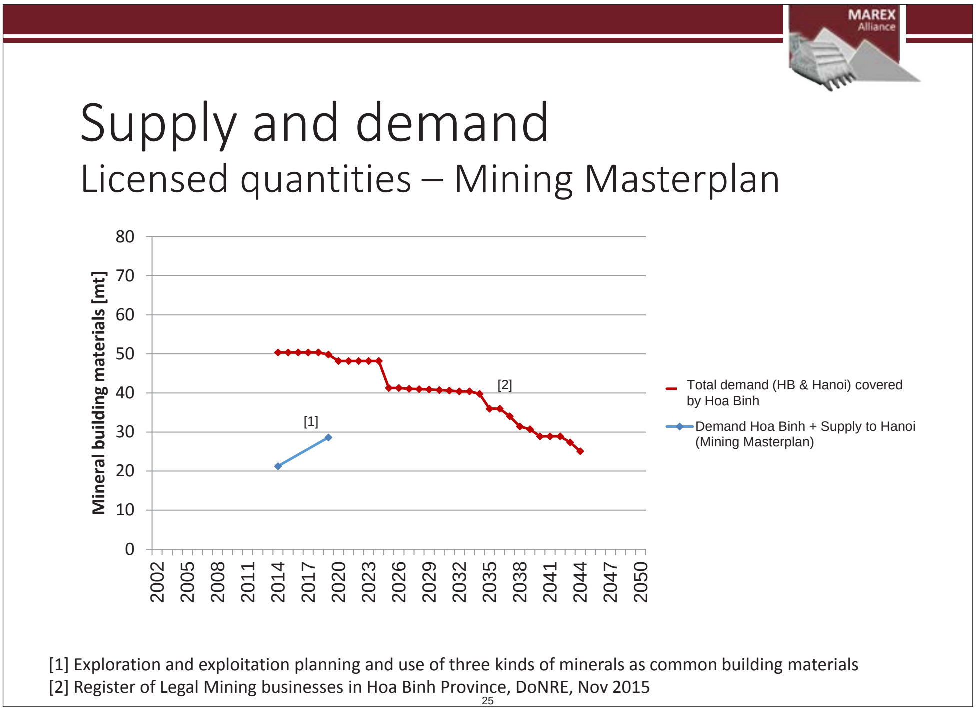
[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials: **Stones** and **sand** for construction materials, **clay for bricks** in Hoa Binh province, period 2014-2019, with a vision to 2024", p.42 ff

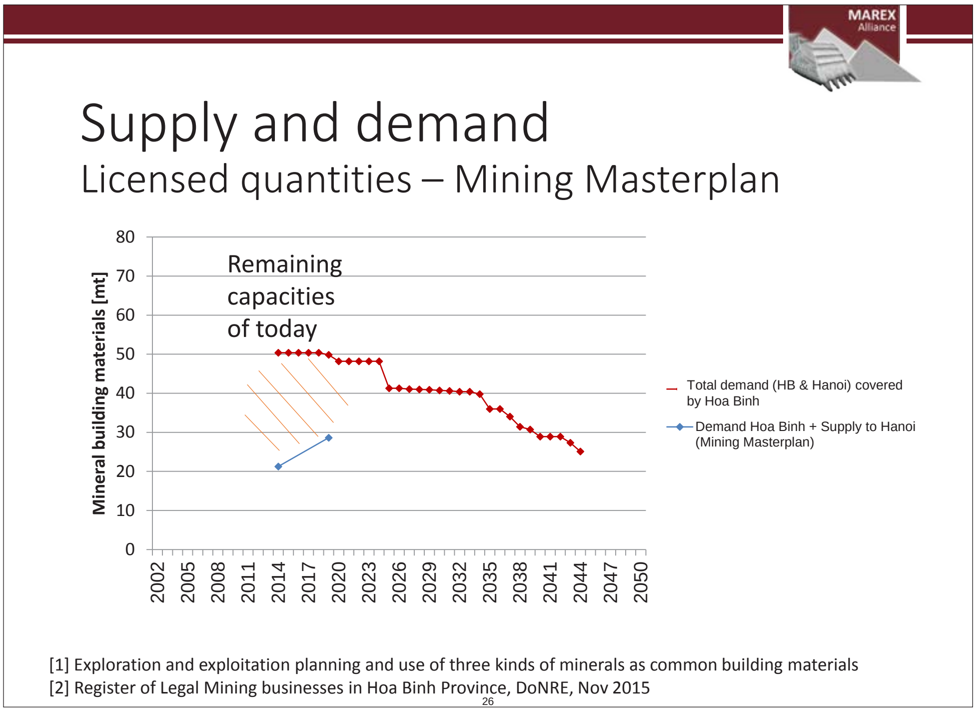
23

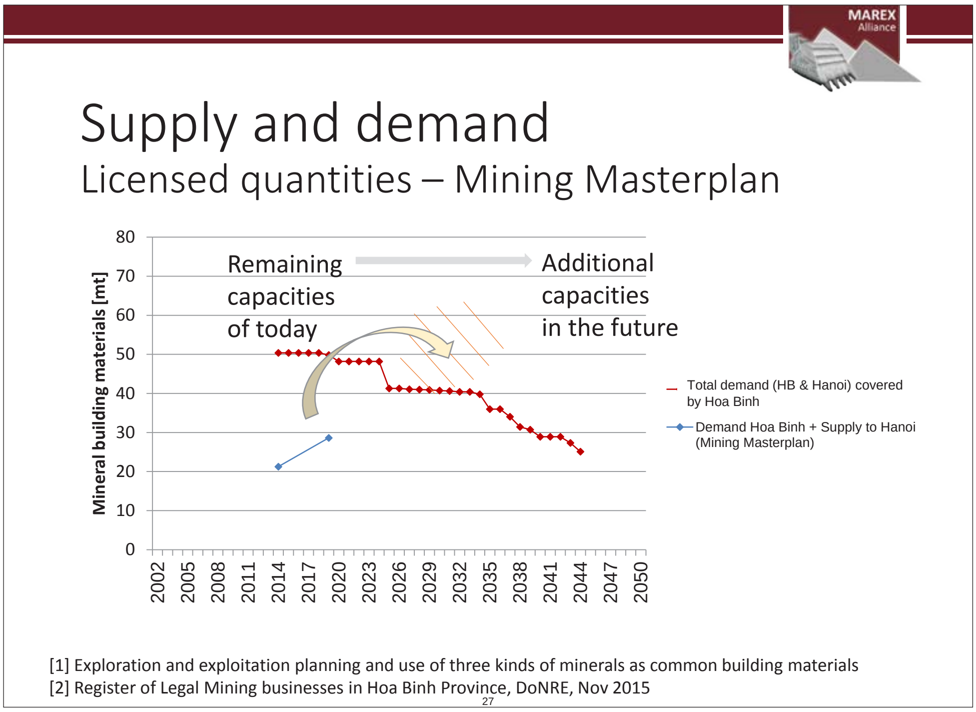
Outlook

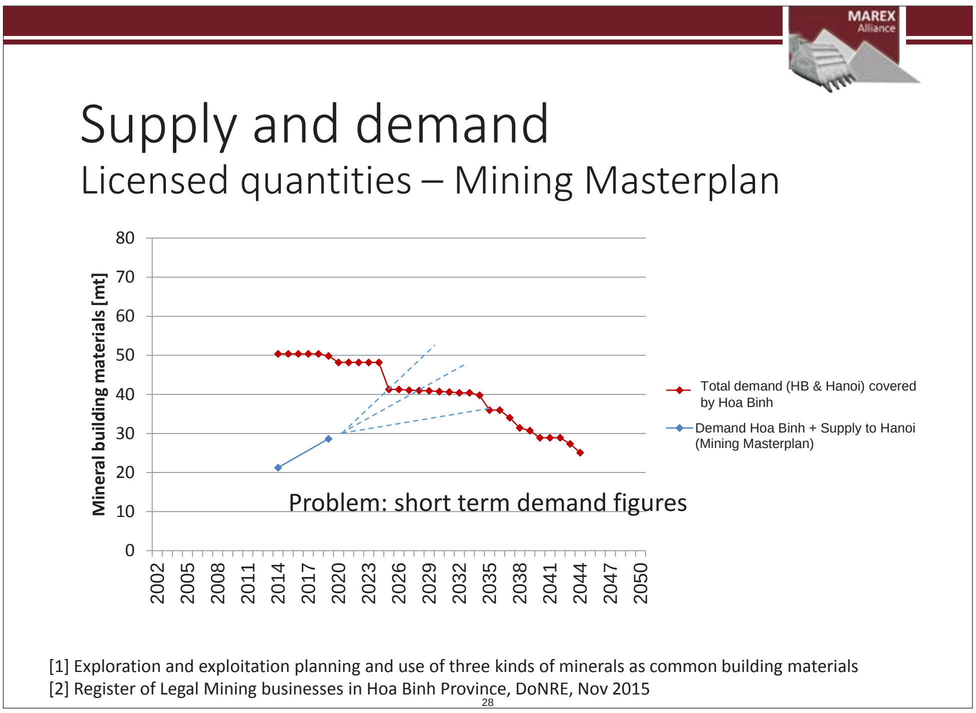
- MFA – Approach
- Supply
  - licensed capacities
- **Demand**
  - **figures reported in master plans**
  - long-term estimation (top down)
  - differentiated long-term calculation (bottom up)
- **Supply – demand relation (1)**
- Conclusion

24


MAREX
Alliance
Supply and demand
Licensed quantities – Mining Masterplan
Mineral building materials [mt]
0
10
20
30
40
50
60
70
80
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
2032
2035
2038
2041
2044
2047
2050
[1]
[2]
Total demand (HB & Hanoi) covered by Hoa Binh
Demand Hoa Binh + Supply to Hanoi (Mining Masterplan)
[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials
[2] Register of Legal Mining businesses in Hoa Binh Province, DoNRE, Nov 2015
25


MAREX
Alliance
Supply and demand
Licensed quantities – Mining Masterplan
Mineral building materials [mt]
Remaining capacities of today
0
10
20
30
40
50
60
70
80
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
2032
2035
2038
2041
2044
2047
2050
Total demand (HB & Hanoi) covered by Hoa Binh
Demand Hoa Binh + Supply to Hanoi (Mining Masterplan)
[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials
[2] Register of Legal Mining businesses in Hoa Binh Province, DoNRE, Nov 2015
26


MAREX
Alliance
Supply and demand
Licensed quantities – Mining Masterplan
Mineral building materials [mt]
80
70
60
50
40
30
20
10
0
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
2032
2035
2038
2041
2044
2047
2050
Remaining capacities of today
Additional capacities in the future
Total demand (HB & Hanoi) covered by Hoa Binh
Demand Hoa Binh + Supply to Hanoi (Mining Masterplan)
[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials
[2] Register of Legal Mining businesses in Hoa Binh Province, DoNRE, Nov 2015
27


MAREX
Alliance
Supply and demand
Licensed quantities – Mining Masterplan
Mineral building materials [mt]
80
70
60
50
40
30
20
10
0
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
2032
2035
2038
2041
2044
2047
2050
Problem: short term demand figures
Total demand (HB & Hanoi) covered by Hoa Binh
Demand Hoa Binh + Supply to Hanoi (Mining Masterplan)
[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials
[2] Register of Legal Mining businesses in Hoa Binh Province, DoNRE, Nov 2015
28

MAREX Alliance

Outlook

- MFA – Approach
- Supply
  - licensed capacities
- **Demand**
  - figures reported in master plans
  - **long-term estimation (top down)**
  - differentiated long-term calculation (bottom up)
- Supply – demand relation
- Conclusion

29

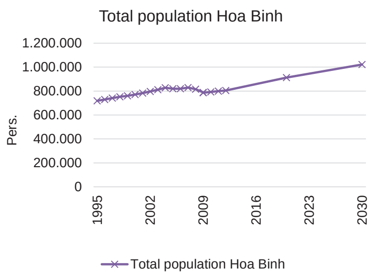
MAREX Alliance

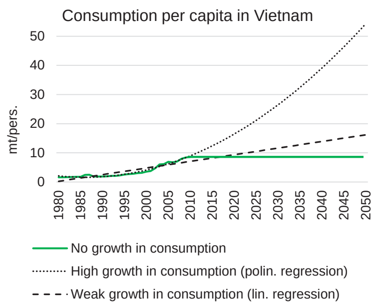
Long-term demand estimation
Top-down

population

x

consumption per person

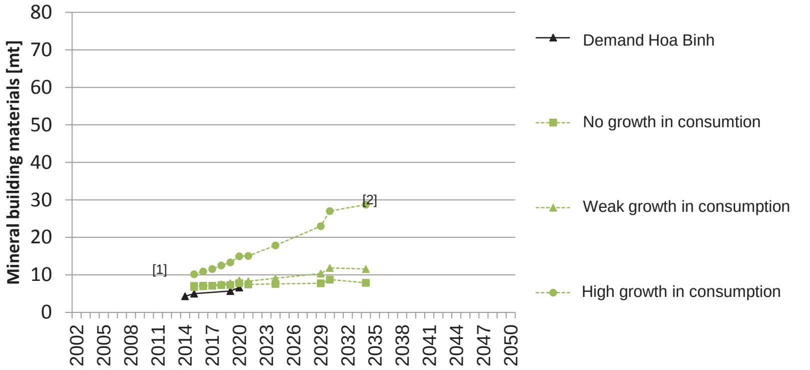




30

Long-term demand estimation

Top-down



[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials
[2] Own calculations

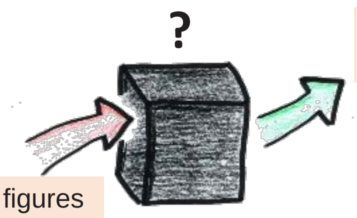
31

Top down calculation

Pros and cons

+ Easy to calculate

- Poor differentiated
- High uncertainty



- Single economic figures

- No insight into the blackbox
- No benefit for integrated planning

32

MAREX Alliance

Outlook

- MFA – Approach
- Supply
  - licensed capacities
- **Demand**
  - figures reported in master plans
  - long-term estimation (top down)
  - **differentiated long-term calculation (bottom up)**
- Supply – demand relation
- Conclusion

33

MAREX Alliance

Typical Vietnamese housing types

Permanent housing

Tubehouses

Detached house

Apartment block / Hotel

Semi-permanent housing

Semi-permanent dwellings

34

Typical Vietnamese road types

Pavement types

Asphalt concrete

Concrete pavement

Soil

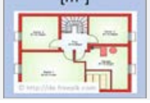
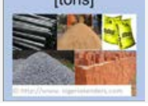
Bitumen Treatment pavement

Road classes

National Highway	Class I
	Class II
	Class III
	Class IV
Rural Road	Provincial Road
	District Road
	Commune Road
Urban Road	Arterial
	Collector
	Local Street

35

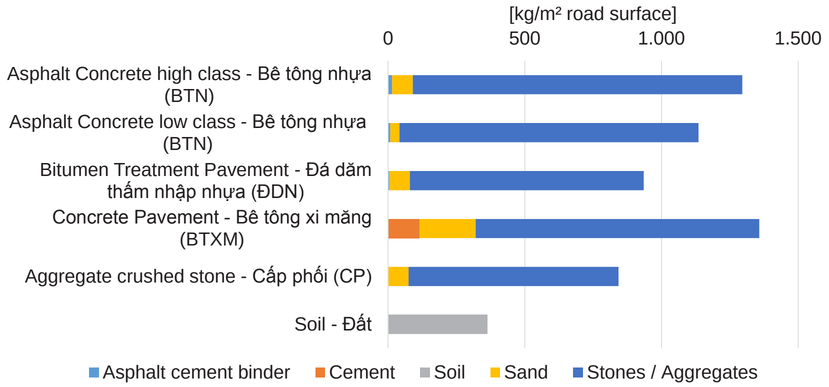
Bottom-up calculation model

	MCI	x	Metric figure	=	Mass
Roads	Specific mass [tons per m²] 	×	Metric flow / stock [m²] 	=	Absolute mass [tons] 
Buildings	Specific mass [tons per m²] 	×	Metric flow / stock [m²] 	=	Absolute mass [tons] 

Material flow (t_i) = Stock (t_i) - Stock (t_{i-1})

36

Material composition Indicators (MCI) of common pavement types in Vietnam

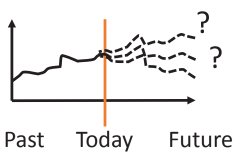


37

Bottom-up calculation model Roads

Flow =	Δ m² road surface	*	MCI

Length road network [m] * Width [m] * Pavement types, road classes [m, %]



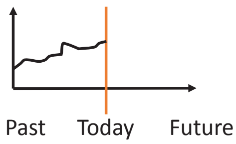
38

Bottom-up calculation model Roads

Flow =	Δ m² road surface	*	MCI

Length road network [m] * Width [m] * Pavement types, road classes [m, %]

- Length road network [m] → Statistical data
- Width [m] → Standards
- MCI → Expert knowledge, standards



Roads - Metric figures

Flow =	Δ m² road surface	*	MCI

Length road network [m] * Width [m] * Pavement types, road classes [m, %]

Statistical data

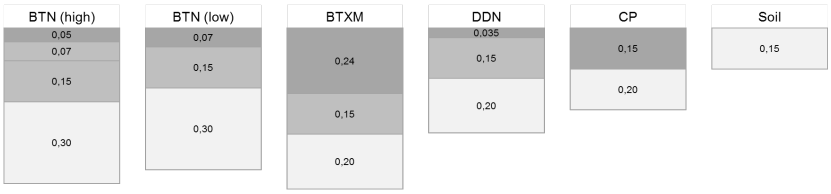
Road classes (RC)

National Highway	Class I (not in Hoa Binh)
	Class II (not in Hoa Binh)
	Class III
	Class IV
Rural Road	Provincial Road
	District Road
	Commune Road
Urban Road	Arterial
	Collector
	Local Street

Pavement types (PT)

Asphalt Concrete (high class)	BTN - Bê tông nhựa
Asphalt Concrete (low class)	BTN - Bê tông nhựa
Bitumen Treatment Pavement	ĐDN - Đá dăm (thấm nhập) nhựa (or Láng nhựa)
Concrete Pavement	BTXM - Bê tông xi măng
Aggregate crushed stone	CP - Cấp phối
Soil	Đất

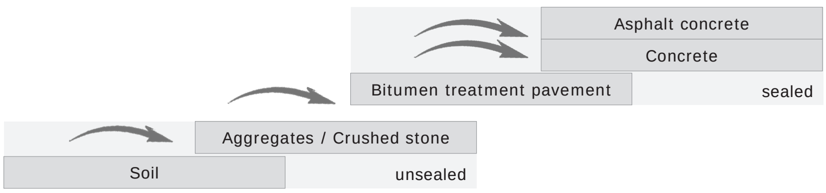
Roads - MCIs

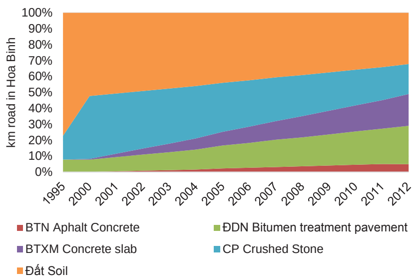


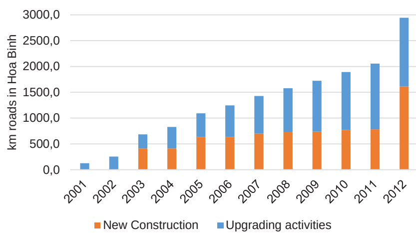
	Wearing course	Binder course	Base	Subbase
Asphalt Concrete (high class)	Fine asphalt concrete	Rough asphalt concrete	Aggregate crushed stone type 1	Aggregate crushed stone type 2
Asphalt Concrete (low class)	Rough asphalt concrete		Aggregate crushed stone type 1	Aggregate crushed stone type 2
Bitumen Treatment Pavement	Asphalted aggregate crushed stoned (small size)	Crushed stones		Natural aggregate stone
Concrete Pavement	Concrete	Crushed stones reinforced with 6% cement		Aggregate crushed stone type 2
Aggregate crushed stone	Crushed stones			Natural aggregate stone
Soil	Soil			

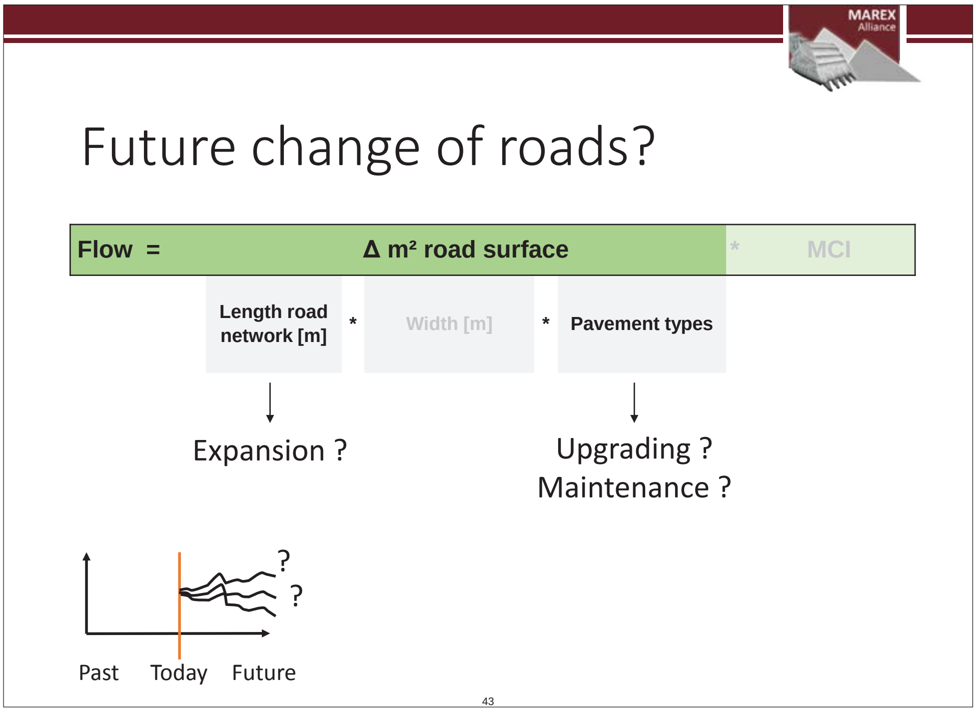
Assumptions

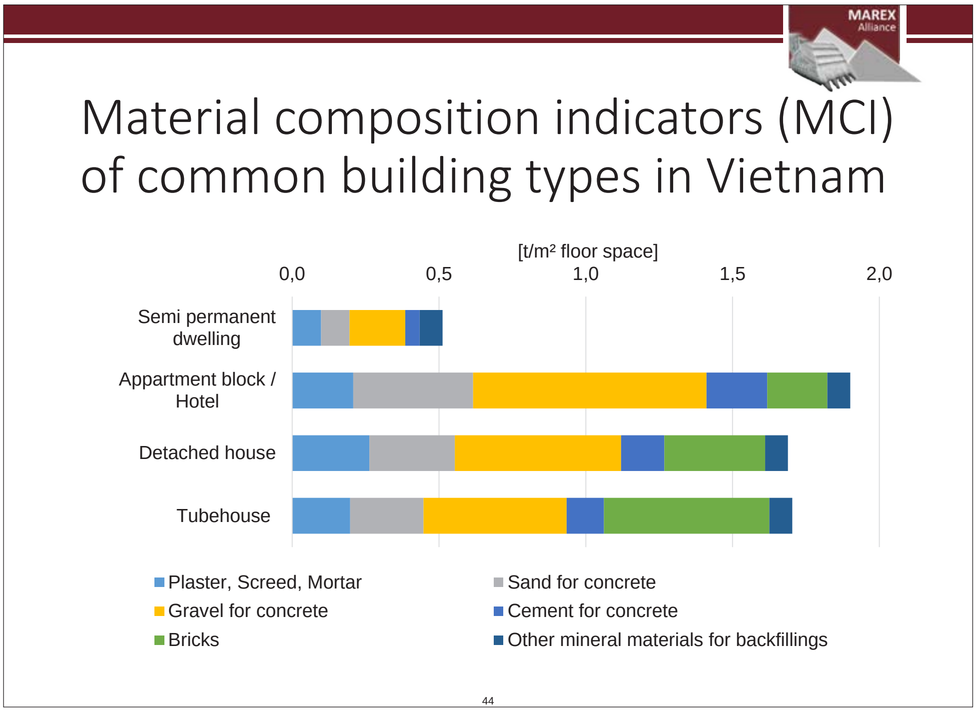
New construction & Upgrading







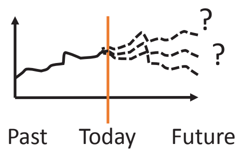

MAREX
Alliance
Future change of roads?
Flow =
Δ m² road surface
*
MCI
Length road network [m]
*
Width [m]
*
Pavement types
Expansion ?
Upgrading ?
Maintenance ?
?
?
Past
Today
Future
43


MAREX
Alliance
Material composition indicators (MCI) of common building types in Vietnam
[t/m² floor space]
0,0
0,5
1,0
1,5
2,0
Semi permanent dwelling
Appartment block / Hotel
Detached house
Tubehouse
Plaster, Screed, Mortar
Sand for concrete
Gravel for concrete
Cement for concrete
Bricks
Other mineral materials for backfillings
44

Bottom-up calculation model
Residential buildings (RB)

Flow =	Δ m² net floor area (NFA)	*	MCI

population [pers] * living area per person [m² /pers] * types of houses [%]



45

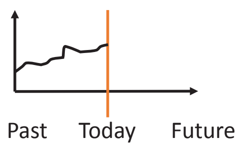
Bottom-up calculation model
Residential buildings (RB)

Flow =	Δ m² net floor area (NFA)	*	MCI

population [pers] * living area per person [m² /pers] * types of houses [%]

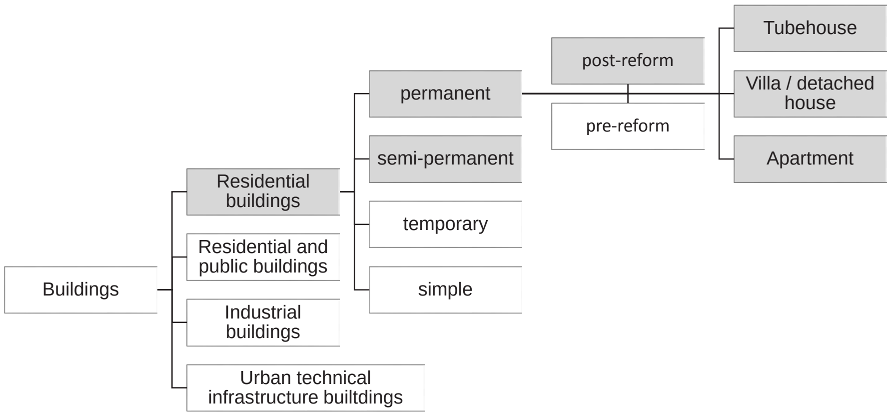
Statistical data

Expert knowledge, standards



46

Buildings - Typology

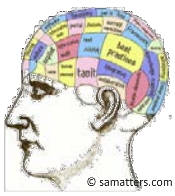


grey: analysed building types

47

Buildings - MCIs

Planning documents



Expert knowledge

No.	CODE	TASK	TASK Translation	UNIT	Quantity	
					BREAK DOWN	TOTAL
1	TT	Công tác chuẩn bị mặt bằng thi công	Preparing for construction plan			1,000
		1	1		*1,000*	
2	TT	Đào đất móng+hầm phân+ bể nước ngầm	Foundation excavation+ Septic tank+ ground water basin	m3		51,365
		Móng M2: 1,4 x 2 x 1,7 x 1,3 x 2	Foundation M2: 1,4 x 2 x 1,7 x 1,3 x 2		*12,376*	
		M3: 2,8 x 1,4 x 1,7 x 1,3 x 2	M3: 2,8 x 1,4 x 1,7 x 1,3 x 2		*17,326*	
		Móng M1: 1,4 x 1,4 x 2 x 1,7 x 1,3	Foundation M1: 1,4 x 1,4 x 2 x 1,7 x 1,3		*8,663*	
		Hầm phân: 8	Septic tank: 8		*8,000*	
		Bể nước ngầm: 5	Ground water basin: 5		*5,000*	
3	TT	Vận chuyển đất ra khỏi công trình	Moving soils out of the construction	m3		34,267
		Bằng 2/3 khối lượng đào: 2 / 3 x 51,4	2/3 of the excavated soil volume		*34,267*	

Bills of Qualtities

MCIs

48

MAREX Alliance

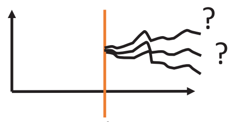
Future change of buildings?

Flow = Δ m² net floor area (NFA) * MCI

population [pers] * **living area per person [m² /pers]** * **types of houses [%]**

Official forecasts

New technologies ?
Housing types ?



Past Today Future

49

MAREX Alliance

Outlook

- MFA – Approach
- Supply
  - licensed capacities
- **Demand**
  - figures reported in master plans
  - long-term estimation (top down)
  - differentiated long-term calculation (bottom up)
- **Supply – demand relation (2)**
- Conclusion

50

MAREX Alliance

Assumptions

Flow = Δ m² road surface * MCI

Length road network [m] * Width [m] * **Pavement types**

Correlation to development of buildings + demolition rate

No variation

Flow = Δ m² net floor area (NFA) * MCI

population [pers] * **living area per person [m² /pers]** * **types of houses [%]**

Official forecasts + demolition rate

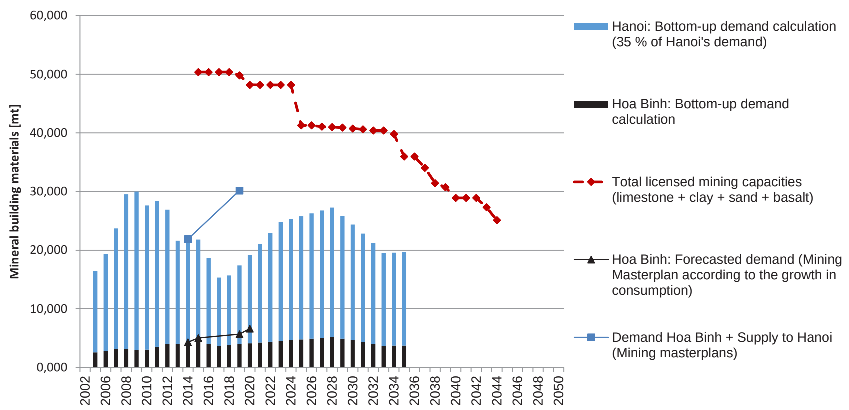
No variation

No variation

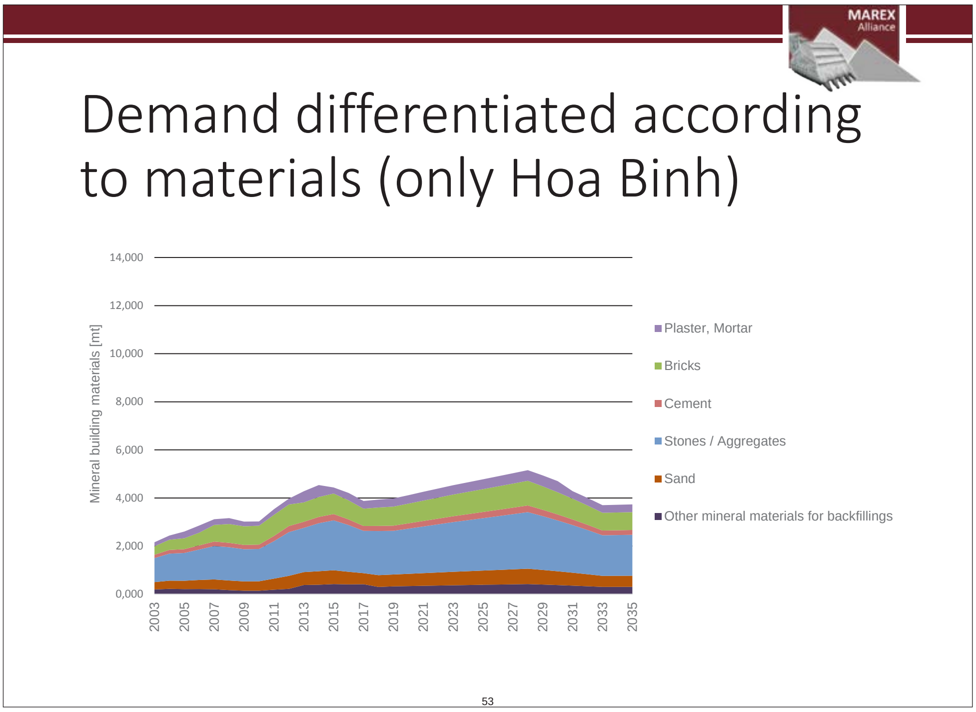
51

MAREX Alliance

Supply ←→ Bottom up demand



52


MAREX
Alliance
Demand differentiated according to materials (only Hoa Binh)
Mineral building materials [mt]
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0,000
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035
Plaster, Mortar
Bricks
Cement
Stones / Aggregates
Sand
Other mineral materials for backfillings
53

Topic 4

Operational material flow management – Environmental Impact Assessment

Operational material flow management – Environmental Impact Assessment

*Pham Thi Viet Anh**

Demand for infrastructure construction is constantly increasing in Vietnam. In past years, mining operations have been able to supply the large masses of required mineral building materials. Yet these activities also release large amounts of substances into the surrounding environment as suspended dust and toxic gases, which negatively impact ecosystems and humans, especially those who work directly at mining sites. According to the Vietnam Law of Environmental Protection, an environmental impact assessment (EIA) report has to be concluded for any investment project in order to assess environmental impacts and to propose mitigation measures for negative impacts.

The presentation aimed to give some basic information on one of the standard tools effectively applied in environmental management, namely Environmental Impact Assessment. EIA is an instrument to identify and assess the potential environmental impacts of a proposed project, to evaluate alternatives and to design appropriate mitigation steps. The presentation focused on the concepts of EIA and the classification of environmental impacts according to the World Bank, including cumulative impacts, which are rarely considered in Vietnam. It also gave necessary contents of EIA and methods applied for impact analysis, assessments and predictions in general and for mineral mining sites in particular. For the purposes of illustration, some pictures and charts were presented of current environmental impacts of mining sites in Luong Son, Hoa Binh (case study area of the MAREX project).

* All images are provided by the authors own expense and do not infringe the right of third parties

Environmental Impact Assessment

PHAM THI VIET ANH, PHD
Faculty of Environmental Sciences, VNU University of Science
Research Centre for Environmental Mornitoring and Modeling

Environmental Assessment

(2) ĐÁNH GIÁ MTCL (ĐMC)	(3) ĐÁNH GIÁ TĐMT (ĐTM)	(3) ĐÁNH GIÁ Chất lượng MT
STRATERGIC ENVIRONMENTAL ASSESSMENT (SEA)	ENVIRONMENTAL IMPACT ASSESSMENT (EIA)	ENVIRONMENTAL QUALITY ASSESSMENT

2

2

1. What is the Environment?

a. Definition in the Vietnam Law on Environmental Protection (2014):

“The environment is *system of natural and artificial material factors* affecting on existence and development of human - being and creatures”.

b. Definition of the World Bank:

“The environment is a set of natural and human features, which exist in a given place and point in time. In general the environment consists of *physical environment, biological environment and human environment”.*

2. What is Environmental Impact Assessment

a. WB (OP 4.01, Feb. 2011):

An instrument to identify and assess the potential environmental impacts of a proposed project, evaluate alternatives, and design appropriate mitigation, management, and monitoring measures. Projects and subprojects need EIA to address important issues not covered by any applicable regional or sectoral EA.

b. Law on Environmental Protection (2014):

“EIA is analysis, prediction of impacts caused by a particular investment project to the environment to provide measures for environmental protection during project implementation”.

3. Purposes of EIA

To ensure that environmental considerations are explicitly addressed and incorporated into the development decision making process;

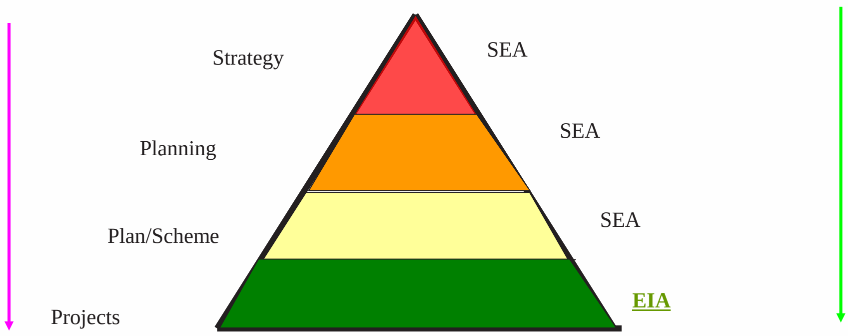
(ii) To anticipate and avoid, minimize or offset the adverse significant biophysical, social and other relevant effects of development proposals;

(iii) To protect the productivity and capacity of natural systems and the ecological processes which maintain their functions;

(iv) To promote development that is sustainable and optimize resource use and management opportunities.

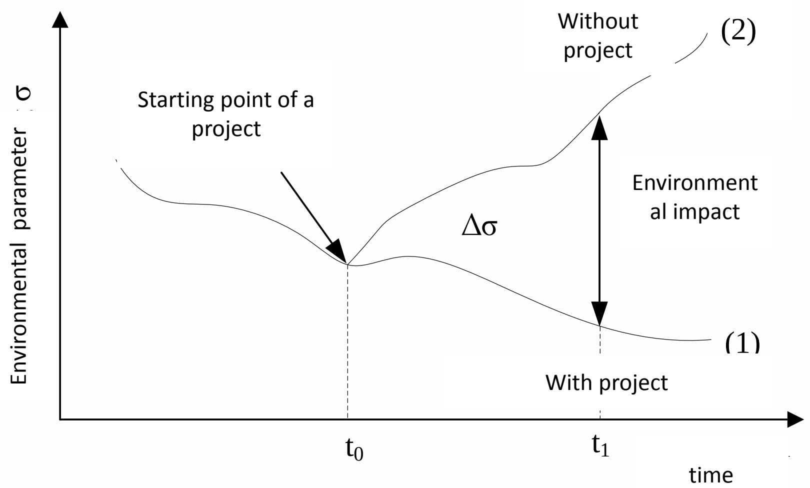
(IAIA – IEA, UK "Principles of Environmental Impact Assessment Best Practice", Jan.1999)

4. SEA, EIA relations



5. What is an Environmental Impact ?

- An environmental impact of a project: the change of existing environmental conditions, or the creation of beneficial or harmful environmental consequences (WB, 2005).
- An environmental impact in space and with time is represented by the change in the value of an environmental parameter before and after the project implementation.



Figue 1. An environmental impact

6. TYPOLOGY OF ENVIRONMENTAL IMPACTS

(Source: World Bank)

Category of Impacts	Type of Impacts
Type	Biophysical, social, health or economic
Nature	Direct or indirect, cumulative, etc.
Magnitude or severity	High, moderate, low
Extent	Local, regional, trans boundary or global
Timing	Immediate/long term
Duration	Temporary/permanent
Uncertainty	Low likelihood/high probability
Reversibility	Reversible/irreversible
Significance*	Unimportant/important

9

Type of impacts

(Source: World Bank Environmental Safeguard Policies)

Term	*Definition*
Impact Nature	
Negative Impact	• An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor
Positive Impact	• An impact that is considered to represent an improvement on the baseline or introduces a new desirable factor
Neutral Impact	• An impact that is considered to represent neither an improvement nor deterioration in baseline conditions
Impact Category	
Direct Impact	• Impacts that result from a direct interaction between a planned project activity and the receiving environment (eg. between occupation of an area of seabed and the habitats which are lost)
Secondary Impact	• Impacts that follow on from the primary interactions between the project and its environment as a result of subsequent interactions within the environment (eg. loss of part of a habitat affects the viability of a species population over a wider area)
Indirect Impact	• Impacts that result from other activities that are encouraged to happen as a consequence of the Project (eg. project implementation promotes service industries in the region)
Cumulative Impact	• Impacts that act together with other impacts to affect the same environmental resource or receptor

Type of impacts

(Source: World Bank Environmental Safeguard Policies)

Impact Duration	
Temporary	• Impacts are predicted to be of short duration and intermittent/ occasional in nature
Short-term	• Impacts that are predicted to last only for a limited period (eg. during facility de-construction) but will cease on completion of the activity, or as a result of mitigation/ reinstatement measures and natural recovery
Long-term	• Impacts that will continue over an extended period. These will include impacts that may be intermittent or repeated rather than continuous if they occur over an extended time period
Permanent	• Impacts that occur once on development of the Project and cause a permanent change in the affected receptor or resource (eg. the loss of a sensitive habitat) that endures substantially beyond the Project lifetime
Impact Extent	
Local	• Impacts are on a local scale
National	• Impacts are on a national scale (effects extend well beyond the immediate vicinity of the facilities and affect an entire region)
Global	• Impacts are on a global scale (eg. global warming)
Magnitude	
Impact Magnitude	• Estimate of the size of the impact (eg. the size of the area damaged or impacted, the % of a resource that is lost or affected etc.)

11

Type of Impacts

Direct impact

Type of Impacts

Secondary impact

indirect impact

13

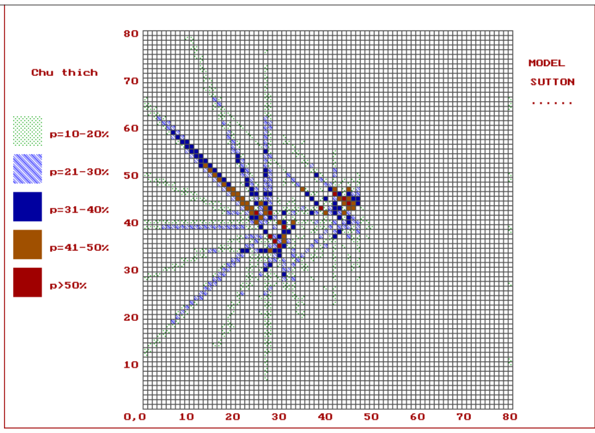
Các loại tác động

Comulative impacts

"Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human activities".

(CEAA = Canadian Environmental Assessment Agency)

CEAA = Canadian Environmental Assessment Agency)

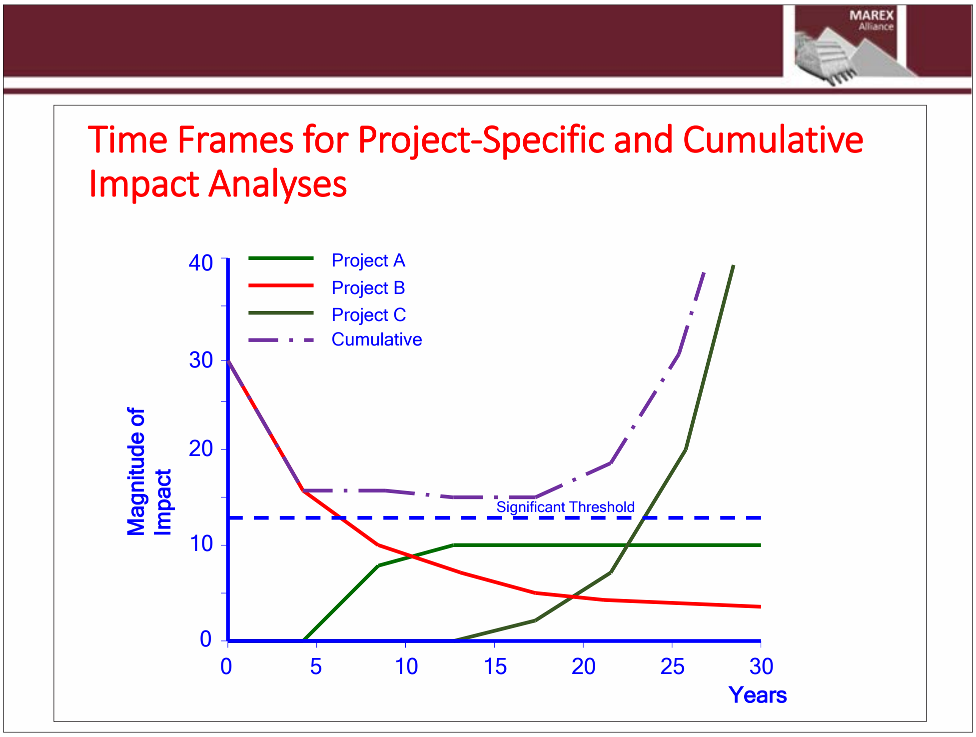


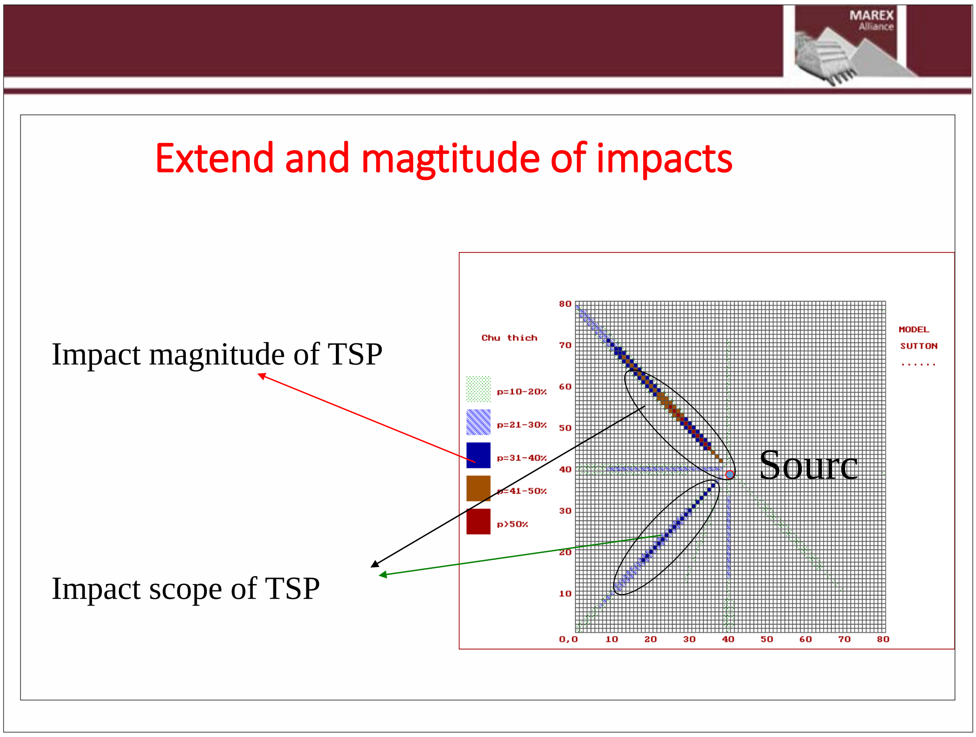
Figue 2. **Comulative impact of TSP from 22 industrial point sources of Hanoi**

What are Cumulative Environmental Impacts?

Definition: Additive and interactive effects of human activities on an ecosystem over space and time

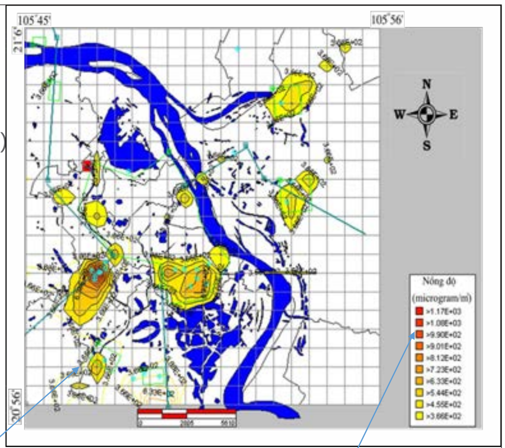
- Single effects almost never occur in isolation, but occur together with many other influences
- Long-term changes may occur not only as a result of a single action but the combined effects or impacts of each successive action on the environment
- Individually minor actions that are insignificant on their own can collectively result in significant impacts over a period of time
- Cumulative impacts result from the accumulation of human-induced changes across space and over time


MAREX Alliance
Time Frames for Project-Specific and Cumulative Impact Analyses
Project A
Project B
Project C
Cumulative
Magnitude of Impact
40
30
20
10
0
Significant Threshold
0
5
10
15
20
25
30
Years


MAREX Alliance
Extend and magtitude of impacts
Impact magnitude of TSP
Impact scope of TSP
Chu thich
p=10-20%
p=21-30%
p=31-40%
p=41-50%
p>50%
MODEL
SUTTON
Sourc
80
70
60
50
40
30
20
10
0,0
10
20
30
40
50
60
70
80

Emission sources:

- Point sources (industrial source)
- Line sources (vehicle source)
- Surface sources



ISC Model

Impact scoping

19

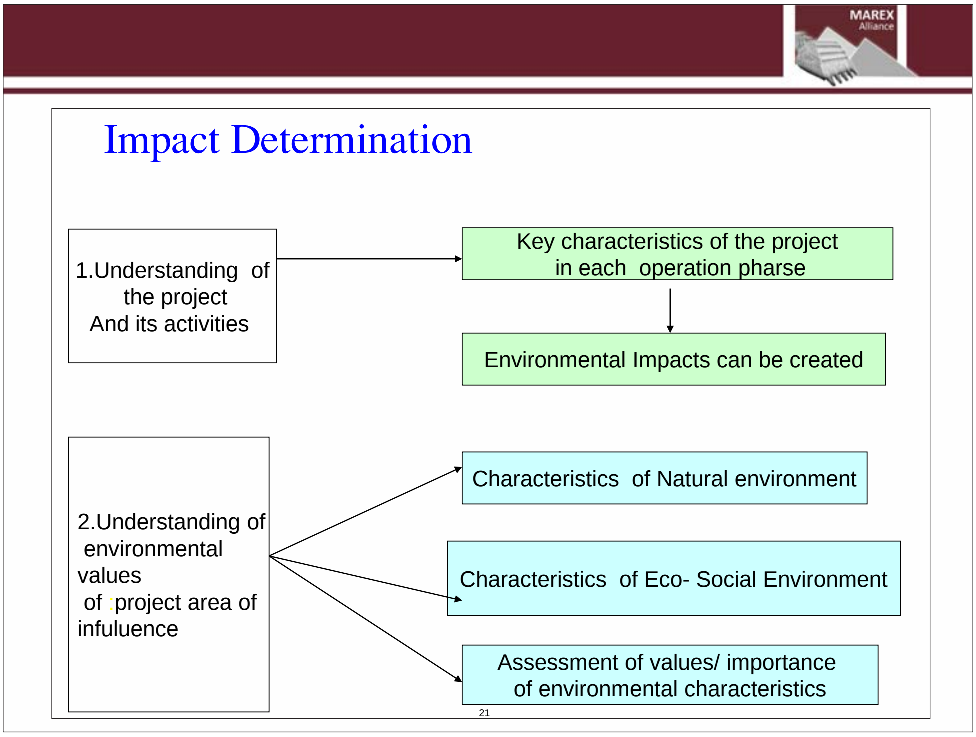
Impact levels

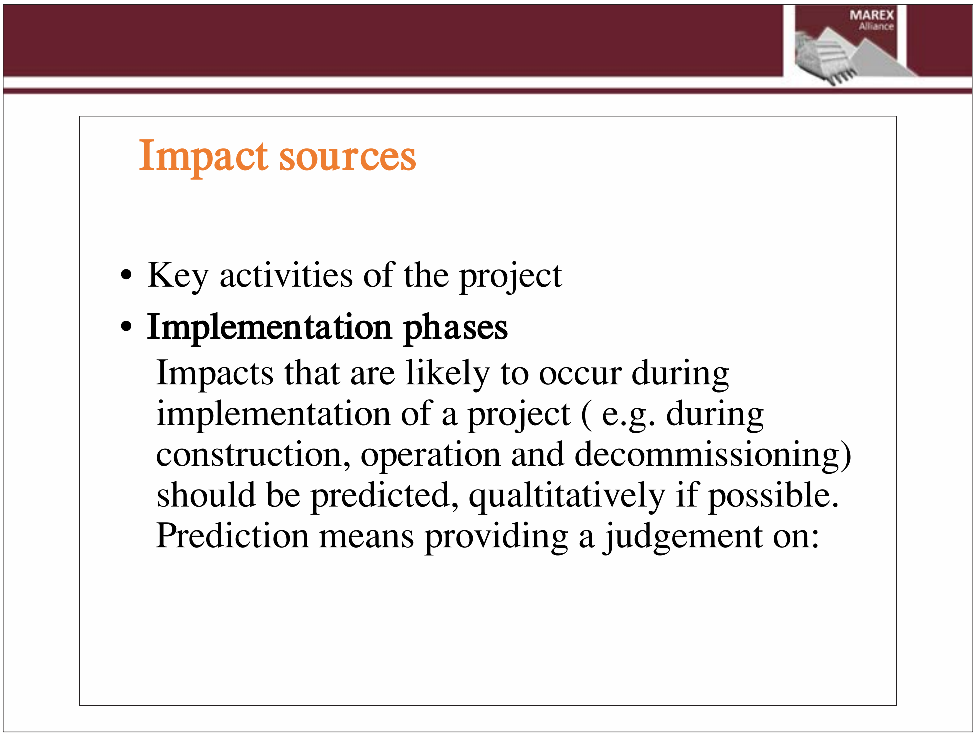
19

7.Environmental Impact Analysis and Assessment

Answer :

- What could happen to the environment as a consequence of doing this project? (prediction)
- Are these impacts important? (evaluation) and
- What can be done about theses impacts to make them acceptable? (mitigation)


Impact Determination
1.Understanding of the project
And its activities
Key characteristics of the project
in each operation pharse
Environmental Impacts can be created
2.Understanding of environmental values
of project area of infuluence
Characteristics of Natural environment
Characteristics of Eco- Social Environment
Assessment of values/ importance
of environmental characteristics
21


Impact sources
• Key activities of the project
• Implementation phases
Impacts that are likely to occur during implementation of a project (e.g. during construction, operation and decommissioning) should be predicted, qualtitatively if possible.
Prediction means providing a judgement on:

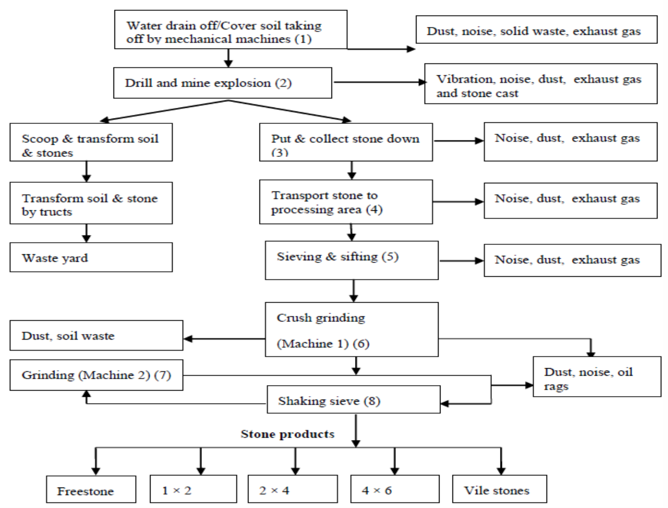


Figure 3. Main sources of pollutant emission from rock exploitation phase for civil construction in Luong Son district, Hoa Binh province

(Source: Dong Kim Loan, Tran Hong Con, Tran Thị Phuong Thuy, Pham Thị Viet Anh, 2017

Impact analysis and assessment

- What impacts might occur?
- What baseline resources/characteristics the impact will affect;
- The magnitude of the impact (i.e. how large the expected change is likely to be e.g % of a resource that is lost, predicted increase in ambient pollutant levels);
- The duration of the impact (i.e. the time period over which the impact is expected to last): and
- The extend of the impact (i.e. the geographical area over which the impact will occur)

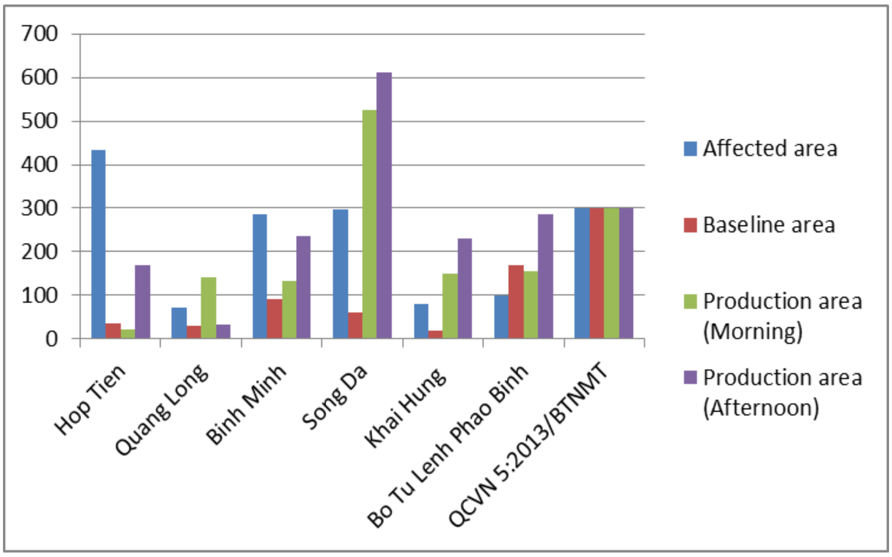
Specifying:
- Impact extend in space: Specific area affected due to transportation of suspended dust from blasting
- Impact objects (workers, locals, ecological system, land use, etc.) and Impact magnitude

Working environment

Compared with : Regualation of Health Ministry (3733/2002/QĐBYT)

Microclimate conditions

An employee is preparing food in the camp at the site



Assessment of Surrounding Environmental Quality:

Compared with the Vietnamese National Technical Regulation on Environment (QCVN)

Abient air quality: compared with QCVN 05:2013/BTNMT

28

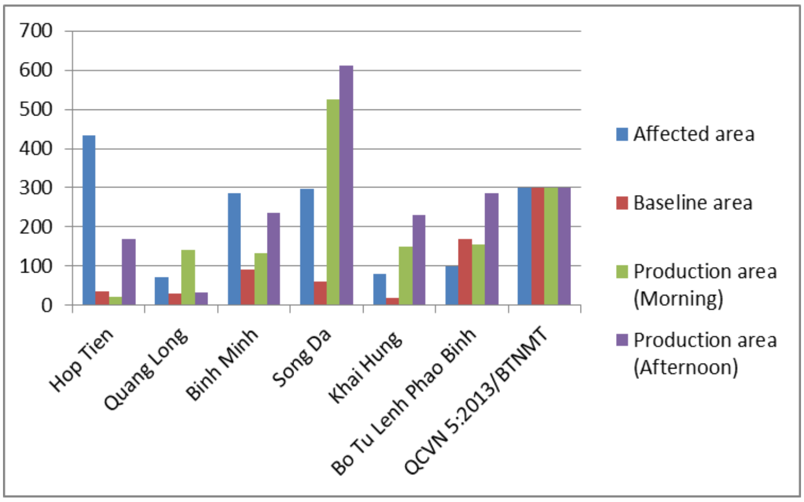


Figure 4. The graphs comparing concentration of TSP in different areas due to activities mining sites (µg/m³)

Impacts on Landscape

Impact on life quality in the area

- Creating jobs for people in the area
- Affected by dust pollution, noise, vibration.
- Workers and people often suffer from respiratory and skin diseases

Incidents and risks

Risk of unsafety electricity

Incidents can occur due to runoff water

Main methods applied for environmental impact identification, prediction and assessment:

- Check - list
- Matrix
- Network
- Map overlay and GIS
- Analysis of environmental indicators
- Environmental modeling
- Professional judgments

Matrix

1. Simple Matrix:

- **Matrix with remarks to identify levels of impacts**

2. Matrix with weighting scores:

- **to identify and preliminarily evaluate levels of impacts (Leopold matrix)**

Simple Impact Matrix

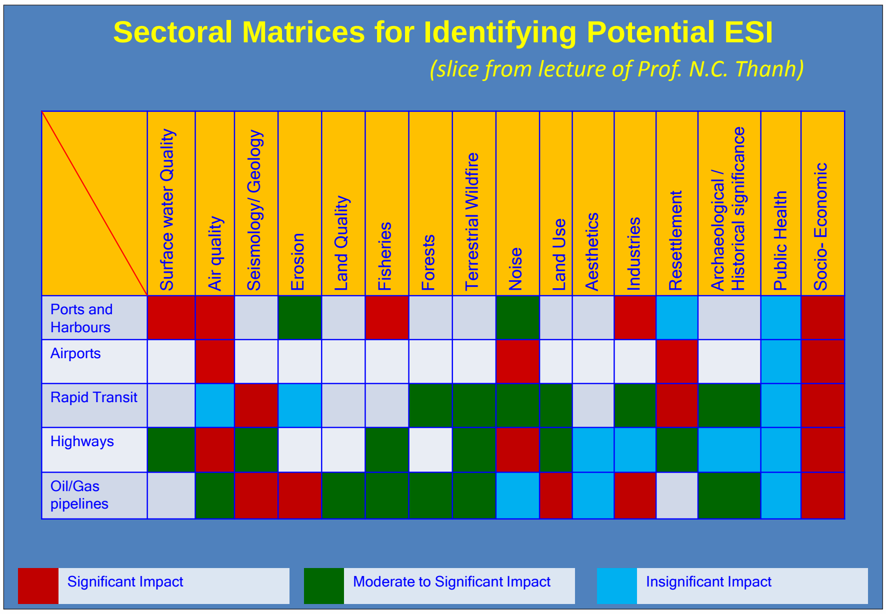
- Illustrates the effects shown by individual project activities
- Displays Project actions on one axis and appropriate environmental parameters on the other

Technique

- –Identify potential impacts of sectoral projects
- –Identify project activities
- –Identify environmental functions affected by individual activity

Activities

- ▪Pre Construction Phase
- ▪Construction Phase
- ▪Operational Phase

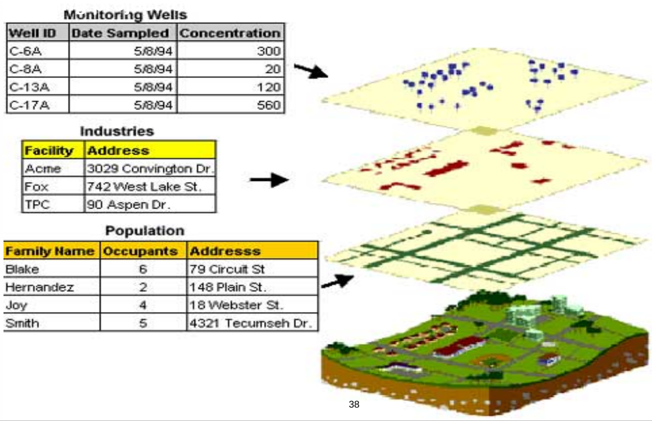


A simple matrix shows the relationship between project activities and environment elements of a quarrying site

Env. element / Activities	vegetation	soil	Surface water quality	Air quality	Local infrastructure works	Terrestrial ecosystems	Aquatic ecosystem	Production activities/travel of the people	Public health
Leveling, infrastructure construction	***	***		***		***			
Removal of vegetation and soil layer cover	***	***		***					
blasting				***	***			***	***
Transportation				***	***			***	***
Stone processing			***				***	***	
Equipment and machinery maintenance,			***						
Activities of mine workers			***				***		
Environmental reimbursement	***	***	***	***		***	***		

MAP OVERLAYS AND GIS

Use for impact identification: areas to be affected, ecological zones to be potentially affected, infrastructural facilities to be potentially affected and suggestion for adjusting project location



38

APPLICATION OF GIS IN ESIA

1. Identifying special impacts of project location
2. Identifying locations of alternative project sites;
3. Identifying areas to be polluted and/or affected by wastewaters or air emissions from the project;
4. Supporting map overlays to identify areas potentially affected by project.
5. Support environmental modeling.
6. Etc.

RAPID ASSESSMENT METHOD (WHO, 1993)

Based on coefficients of pollution loads from different waste generation sources:

- Coefficients pollution loads of waste waters from different industrial sectors,..
- Coefficients pollution loads in air emissions from different industrial sectors, transport facilities,…

ENVIRONMENTAL MODELING

Mathematical models are used for quantification and assessment of impacts caused by pollution sources:

a. Air emission from:

- Fossil fuel used sources (industrial and transport projects)
- Burning (fires)
- Blasting

b. Wastewater, water pollution dispersion

c. Self-purification/loading capacity of rivers, lakes, seas

Noise generation sources (machines, vehicles, airplanes)

f. Vibration generation sources (machines, vehicles,…)

g. Environmental risks (fires, explosion, oil spills…), natural disasters (flood, innundation…)

Modeling in mineral mining

- Calculation of transportation of TS, toxic gases created from blasting
- Calculation of transportation of TS, toxic gases created from on-site transportation facitlites

- Point source without the heigh (Excavating, blasting)

The Sutton Model of air pollution transportation for point source without the heigh (emission from excavating, blasting)

$$C(x,y,0)=\frac{2.M}{\pi.u.C_y.C_z.x^{2-n}}\exp\left[-x^{n-2}\left(\frac{y^2}{C_y{}^2}\right)\right]$$

M: Emission rate (mg/s)
U: Velocity of wind at ground (m/s)
$C_{(x,y,0z)}$: Concentration of poluttants (mg/m^3)
C_y, C_z: Sutton dispersion coefficients
n: indexes related to atmospheric stability
x,y: distance from emission source.

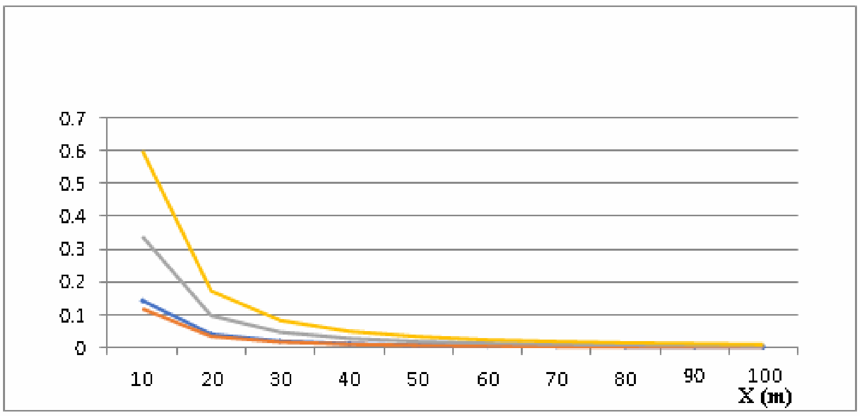


Figure 5. Distribution of TSP concentrations from drilling, blasting, shoveling and loading in the North wind direction in unstable atmospheric conditions

Topic 5

Strategies towards efficient mining

Artificial sand production

Petra Schneider

Based on statistics from 49 provinces and cities, a governmental report issued in August 2017 by the Department of Construction Materials in the Vietnam Ministry of Construction indicated that, by the end of 2016, permits had been issued to allow the mining of 691 million m3 of natural sand and gravel. Ministry surveys based on data from 2015 revealed that up to 50-60 million m3 of sand are needed to meet the annual demand of current construction projects in the country. According to information from the Ministry of Construction, domestic demand for construction sand between 2016 and 2020 is estimated at around 2.1-2.3 billion m³, while the country's total natural sand reserves are about 2 billion m³. With this rate of sand consumption, Vietnam will run out of natural sand as a building material by 2020.

Meanwhile, various alternatives to sand are being discussed. For example, sand could be purchased from neighbouring Cambodia (although this solution only shifts the ecological problem temporally and spatially) or builders could make use of solid waste such as clinker and sludge from thermal electrical installations and shipyards. So far, the country has no experience in processing waste as a building material and also no regulatory quality requirements. Another alternative is the use of artificial (or "manufactured") sand, a material which is processed from crushed rock or gravel to produce a fine aggregate of grain size smaller than 4.75 mm. The production line for such sand consists of a vibrating feeder, a jaw crusher, a sand-making machine, a vibrating screen and a belt conveyor as well as other mining equipment. The properties of aggregates extracted from natural sand deposits differ to those made from crushed rock (crushed aggregates). Natural aggregates are weathered, their surface is often smooth and particles are sub-angular to rounded. On the other hand, crushed aggregates have a rough surface texture, the particles are angular and, if the production process is adequate, their shape is cubic. Properties of the parent rock (determined by various petrological parameters) have an important influence on the blasting and crushing of manufactured sand, e.g. energy consumption, the production and shape of fines as well as the quality of fresh and hardened concrete. Rounded grains are needed for the production of concrete. The installation of Vertical Shaft Impactors (VSI) has proved an effective way of producing cubic (even rounded) particles in the small- and medium-sized fractions (< approx. 5 mm). The latest generation of dry screening equipment combined with state-of-the-art air classification have, however, enabled highly precise grading curves, including the finest fraction.

In Vietnam, artificial sand cannot yet be sold on the market as a building material despite its much cheaper price as currently there are no regulations governing the quality of artificial sands. This has also resulted in a lack of interest on the part of building companies in this construction material.


MAREX Alliance
MAREX Alliance Workshop
Production of Artificial Sand
A contribution by the Vietnamese-German MAREX Project
November 01-02 2017 • Hoa Binh city • Vietnam


MAREX Alliance
Artificial Sand Production

Artificial Sand

Artificial (or manufactured) sand is a material which has a grain size smaller than 4.75mm based on a fine aggregate and which is processed from crushed rock or gravel.

Figure source: [1]

Artificial Sand - Production

The sand production line consists by vibrating feeder, jaw crusher, sand making machine, vibrating screen and belt conveyor and other mining equipment.

washing by sand washer (optional)

high fines content can be resolved with either wet or dry processing, i.e. different washing techniques or air classification

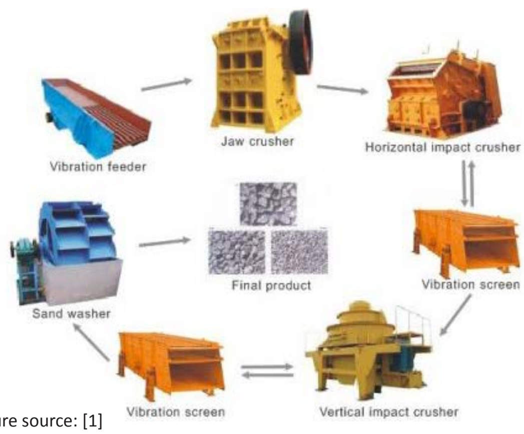


Figure source: [1]

Artificial Sand - Properties

Properties of aggregates from natural sand deposits differ compared to aggregates from crushed rock (crushed aggregates).

Natural aggregates are weathered and their surface is often smooth and particles are sub angular to rounded.

Crushed aggregates on the other hand have a rough surface texture, particles are angular and, if the production process is adequate, their shape is cubical.

Figure source: [2]

Artificial Sand - Properties

Properties of manufactured and natural sand differ

Table: Manufactured sand characteristics [3].

Typical values	Manufactured sand	Natural sand
Grading	packed/dense	open/straight
Filler content (<0,125µm)	10-25%	2-8%
Surface area	2-300.000 m^2/m^3	50-70.000 m^2/m^3
% cubical particles	30-50%	40-95%

Artificial Sand – Artificial sands vs. natural sands

Sr. No.	Artificial Sand / Manufactured Sand / Crushed Sand	Natural (River) Sand
01	Artificial Sand doesn't contain impurities like silt & silica etc. This sand doesn't contain any organic matter so; strength of the structure remains same.	This sand contains impurities like silt, silica etc. It also contains organic impurities like pieces of wood, leaves, bones etc. which after some time duration gets decayed & weakens strength of structure.
02	Artificial Sand is made from only one type of stone so; the binding strength between the particles is good.	Natural Sand is made from different type of stones so; binding strength varies.
03	Artificial Sand has proper gradation of coarse & fine aggregates so; voids are filled completely. This reduces cement consumption.	Natural Sand which is available today, don't have fines below 600 microns in proper gradation. So, voids in the concrete are not filled properly & also increases cement consumption.
04	Artificial Sand better compressive strength as compared to river sand.	Natural Sand gives low compressive strength as compare to Artificial Sand.
05	As the voids are filled properly, strength of the concrete is achieved.	As the voids are not filled properly, strength of the concrete is not achieved.
06	Artificial Sand has constant fineness modules of aggregate so; no necessity of the change in concrete mix design.	As every truck of Natural Sand has different fineness modules, every time concrete mix design have to be changed.

Figure source: [4]

Artificial Sand - Use

According to the machinery producer Nordberg (1999) [4], now Metso, manufactured sand has been used for many years in a variety of concrete applications including waterway and dam projects, highway and airport paving, bridges, power plants, all types of industrial and commercial construction, and concrete products of all kind.

Table: Common aggregate application and average proportions in the world according to Mahonen (1999) [3].

Destination	Proportion
Ready mix concrete (30% sand)	36 %
Mortars	18 %
Pre-cast concrete (25-35% sand)	12 %
Asphalt (35-45%)	9 %
Sub-bases	18 %
Ballast	2 %
Others	5 %

Artificial Sand – Parent rock

When producing manufactured sand, it is possible to select the raw material, i.e. the parent rock.

Properties of the parent rock are determined by various petrological parameters that have an important influence:

- the blasting and
- crushing of manufactured sand, e.g.
- energy consumption,
- fines production and shape,
- but also upon the quality of fresh and hardened concrete.

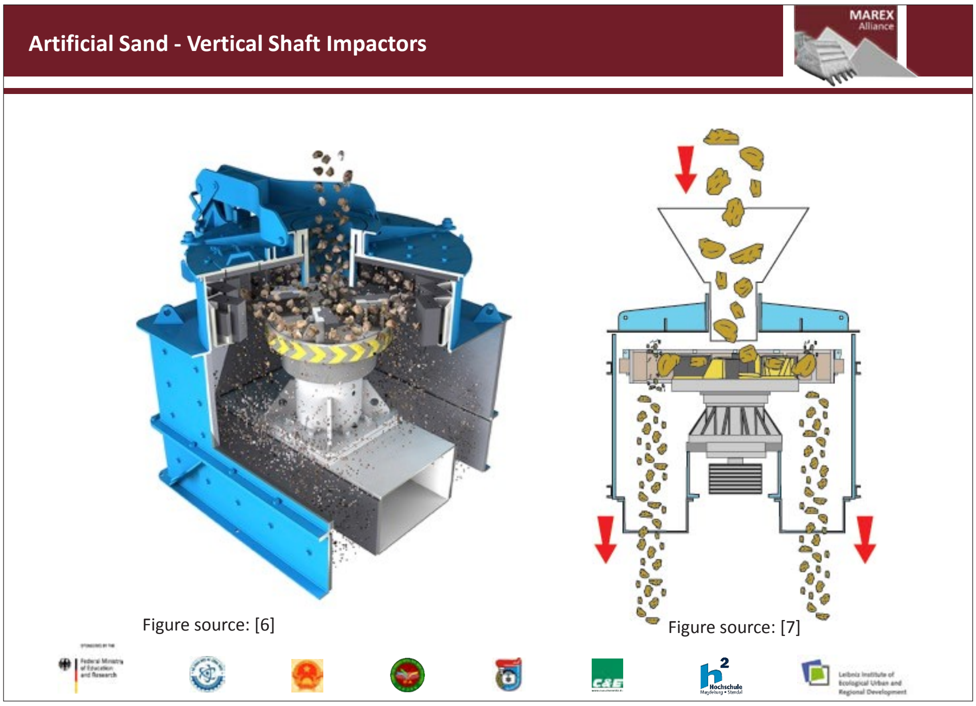
For the production of concrete it is important to produce rounded grains.

Artificial Sand - Processing

The installation of Vertical Shaft Impactors (VSI) has proven to be an effective way of producing cubical or even rounded particles in the small and medium size fractions (< approx. 5 mm) [5].

It is however a challenge to avoid the generation of a high percentage of fines.

The latest generation of dry screening equipment combined with the latest development of air classification have, however, enabled to govern the grading curve very precisely, including the finest part.


Artificial Sand - Vertical Shaft Impactors
MAREX Alliance
Figure source: [6]
Figure source: [7]


Artificial Sand - Vertical Shaft Impactors
MAREX Alliance
Pebble
Limestone
Quartz
More Than 1000 kinds of Materials
Finished Product
Figure source: [8]

Artificial Sand - Quality

Aggregates: (1) High-quality, 0/8 mm natural glaciofluvial sand from Norway; (2) Low-quality, 0/8 mm co-generated material of coarse crushed aggregate production; (3) High-quality, 0/8 mm crushed sand, produced using an optimized crushing circuit and VSI shaping.

Figure source: [8]

Artificial Sand - Storage

However, it is important to be aware that high quality aggregates could be degraded by insufficient procedures of handling and storage.

Alternative storage options might be necessary.

Figure source: [9]

Figure source: [10]

Figure source: [11]

Artificial Sand - Application in concrete

Design of concrete mixes

The difference in surface texture, shape properties and particle surface texture indicates that natural and manufactured sands are two different types of material and must be treated accordingly [2].

These facts require development of new concrete mix designs, and knowledge for the application of this material.

Experiences of traditional concrete mixed design based on natural sand should not be automatically transferred into this new material.

Artificial Sand – Meeting sand demand

Aggregate producers are faced with [2]:

- constant demands for higher quality aggregates and,
- at the same time, have to take environmental issues into account.

Most pressing issues [2]:

- excess amounts of fines (< 4 mm) following the crushing process for manufactured aggregates
- depletion of natural aggregate resources.

Excess fines were, and in many countries still are, considered waste and were disposed of accordingly, at great costs and contamination.

Artificial Sand - Advantages

On international scale, producers recognised an unused opportunity and experimented with manufactured sand from gravel and crushed rock.

Advantage:

- artificial sand has a rough surface texture
- Particle Size Distribution curve can be adjusted when the material is manufactured
- specific properties can be selected by selecting the source rock material.

The results of extensive research programs have in general been in favour of using manufactured sand, given the right conditions concerning rock type and production process [2].

Artificial Sand – Environmental Impact

Energy and Transportation

It is also claimed that the transport of aggregates is more than 20% of all heavy truck transportation, and at transport distances longer than 50-100 km, the cost of the transport exceeds the price of the aggregate [2].

Table: Energy consumption - Crushed gravel production, from blasted rock [2].

Activity	Energy sources	Consumption		CO_2 pr unit		Emission CO_2 (kg CO_2/ton)
Blasting	Explosives	0.25	kg/t	2.66	kg/kg aggregate	0.67
Production	Diesel oil	0.57	liter/t	2.69	kg/litre diesel oil	1.53
Production	Electrical power	2.30	kWh/t	0	kg/kwh	0
					Total	2.20

Artificial Sand – Environmental Impact

Energy and Transportation

Table: Energy consumption - Gravel production from natural sediments [2]

Activity	Energy sources	Consumption		CO_2 pr unit		Emission CO_2 (kg CO_2/ton)
Production	Diesel oil	0.57	litre/t	2.69	kg/litre diesel	1.53
Production	Electrical power	2.50	kWh/t	0	kg/kwh	0
					Total	**1.53**

Table: Energy consumption – Transportation [2]

Type of transport	Energy source	Consumption (litre/km)	Ton pr unit	Consumption (litre/ton x km)	Emission CO_2 (ton/km)
Lorry	Diesel oil	0.6	13	0.0462	0.1242
Vessel, domestic	Diesel oil	5.7	1.000	0.0057	0.0153
Vessel, Export 1	Heavy oil	26.4	4.000	0.0066	0.0178
Vessel, export 2	Heavy oil	64.4	27.000	0.0024	0.0064

CO_2 pr unit: 2.69 kg/litre diesel

Artificial Sand - Technical Challenges

One of the main challenges in aggregate production, especially when producing crushed aggregates from hard rock quarries [12, 13], is to obtain a satisfactory mass balance [14, 15].

→ excess fraction that has to be kept on stock or deposited will create an economic as well as an environmental problem [16].

The production of crushed aggregates normally gives a ***miss-balance of particle sizes***, as the relative quantity of the sand fraction (0-4 mm) in most cases exceeds what can be placed on the market [2].

Quality Assurance Standards for the use of manufactured sand in concrete like in Europe [17] are necessary. Experiences in Asia are under development [18].

Artificial Sand

Beside the production of artificial sand, would it be an option for the production of manufactured from recycled construction and demolition waste as the technological equipment is comparable ?

What is happening with the current construction and demolition waste ?

Artificial Sand – Processing Chain for Recycling Material

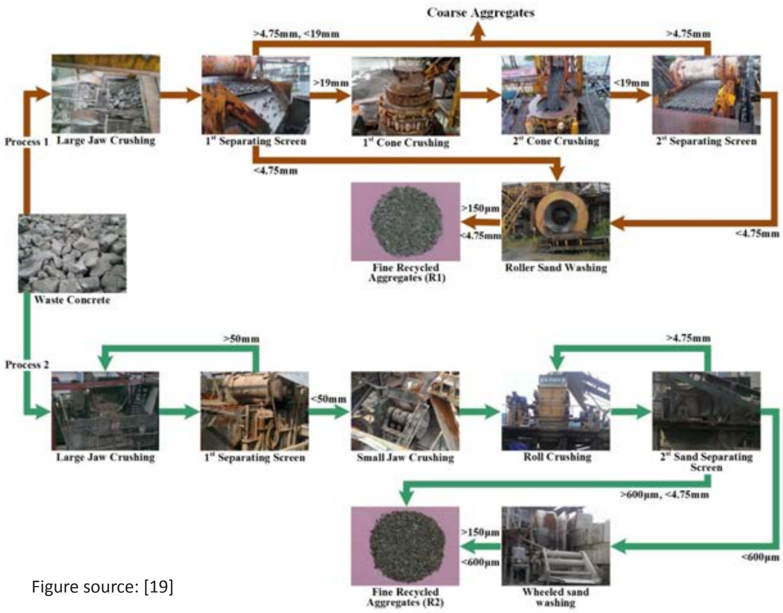


Figure source: [19]

References

[1] available online: http://www.dscrusher.com/solutions/crushing-industry/sand-making-plant.html, accessed 01.10.2017
[2] Wigum, B.J.; Danielsen, S.W.; Hotvedt, O.; Pedersen, B. (2009). Production and Utilisation of Manufactured Sand State-of-the-art Report, COIN Project report 12 – 2009.
[3] Mahonen, J. (1999). SAND: Applications, Manufacturing, Classification, Requirements – Nordberg Way of Sand Making. Nordberg-Lokomo: Tampere.
[4] available online: http://www.artificialsand.com/faqs.html , accessed 01.10.2017
[5] Cepuritis, R.; Jacobsen, S.; Onnela, T. (2015). Sand production with VSI crushing and air classification: Optimising fines grading for concrete production with micro-proportioning. Minerals Engineering. vol. 78.
[6] available online: https://www.stedman-machine.com/vsi-primer-article.html , accessed 01.10.2017
[7] available online: http://www.cemcoturbo.com/crushers_works.html , accessed 01.10.2017
[8] available online: https://www.metso.com/showroom/construction/new-type-of-crushed-sand-to-replace-natural-sand-in-concrete-production/, accessed 01.10.2017

References

[9] available online: http://www.pollutionequipmentnews.com/frac-sand-process-water-storage-tanks, accessed 01.10.2017
[10] available online: http://www.meridianmfg.com/flare-tanks/, accessed 01.10.2017
[11] available online: http://steelcostructures.com/index.php?txt=use_en_ind&m=3&lang=en , accessed 01.10.2017
[12] Wigum, B.J., Hólmgeirsdóttir, Þ., Danielsen, S.W. & Andersen, O.V. (2004). Production and Utilisation of Manufactured Sand for Concrete Purposes. Nordic Atlantic Co-operation
[13] Cepuritis, R. (2014). Sand from the rocks. Bulk Solids Handling. vol. 34 (3).
[14] Smith, R.A., Kersey, J.R. & Griffiths, P.J. (2002). The Construction Industry Mass Balance; Resource Use, Wastes and Emissions. Virdis Report ISSN 1478-0143.
[15] Langer, H., Drew, J.; Sachs, J.S. (2004). Aggregates and the Environment. American Geological Institute.

References

[16] Přikryl, R.; Török, A.; Gomez-Heras, M.; Miskovsky, M.; Theodoridou, M. (2016). Sustainable Use of Traditional Geomaterials in Construction Practice; Geological Society, London, Special Publications, 416; ISBN 978-1-86239-725-5.

[17] The European Committee for Standardization (2002). EN 12620:2002, Aggregates for concrete.

[18] Ingalkar, R.S.; Harle, S.M. (2017). Replacement of Natural Sand by Crushed Sand in the Concrete, Landscape Architecture and Regional Planning; 2(1): 13-22, doi: 10.11648/j.larp.20170201.12

[19] Fan, C-C.; Huang, R.; Hwang, H.; Chao, S-J. (2015). The Effects of Different Fine Recycled Concrete Aggregates on the Properties of Mortar, Materials 2015, 8, 2658-2672; doi:10.3390/ma8052658

Advanced mining technologies in open pit mines – drilling and blasting

Wolfgang Riedel

The presentation aimed to introduce the various technologies used to extract mineral materials from open pit mines. After some fundamental definitions and a survey of the state-of-the-art of drilling and blasting, the main requirements for successful blasting and the role of secondary blasting were discussed. In conclusion, an economic evaluation was made and the possibilities of optimizing costs for drilling and blasting were explored.

The objective of advanced mining technologies is to achieve maximum results with minimal effort, which means producing small-sized pile material ready for loading and immediate transfer to the crusher without secondary crushing. State-of-the-art technologies are wellhole blasting and single row or bench blasting. One precondition for efficient execution is a regulated mine development as well as berm mining. Finally, the presentation emphasised the cost savings achieved in drilling and blasting by using drones to monitor mine blasting, by determining optimal ignition sequences, improving the arrangement of the borehole distances and by general enhancements to the blasting process.

Structures of investigated open pit mines – Hoa Binh drilling and blasting



https://www.rnz.de/nachrichten/metropolregion_artikel,-Metropolregion-Mit-dem-Finger-am-Sprengknopf-Explosives-Handwerk-im-Nusslocher-Steinbruch-_arid,217817.html

Drilling

Loading

Blasting

https://www.kalk.de/rohstoff/gewinnung/abbau/

Quang Long
Hop Tien
Bin Minh
DoNRE

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Exploitation → Extracting the rock from the rock mass

90 % by means of drilling and blasting works

Objective: minimal effort with maximum results

- Muck pile ready for loading without secondary crushing
- Immediate transfer to crusher / processing

Quang Long
Hop Tien
Bin Minh
DoNRE

Structures of investigated open pit mines – Hoa Binh drilling and blasting

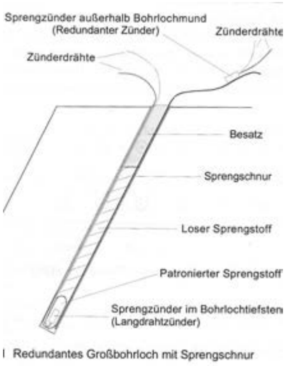
Possible blasting methods with drilling works:

- Wellhole blasting (drill depth > 12 m)
- Single-row or bench blasting (Borehole row by setting parallel to the wall with stope holes)
- Multi-row blasting (max. 3 rows in parallel to the bench)
- Surface blasting (multi-row blasting)
- (Bottom blasting, no longer applied)
- Gentle blasting, compaction of the distances, use of powder explosives

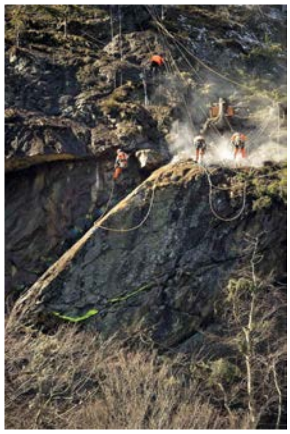
Quang Long
Hop Tien
Bin Minh
DoNRE

Structures of investigated open pit mines – Hoa Binh drilling and blasting

State of the technique:



- Wellhole blasting



- Single-row or bench blasting

Figure source: https://www.blick.ch/news/schweiz/zentralschweiz/sprengung-am-gotthard-verkehrschaos-mit-ansage-wege-ins-tessin-gesperrt-id1801112.html

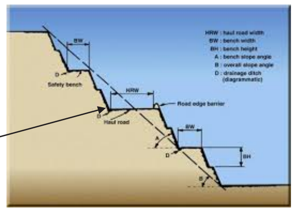
Quang Long
Hop Tien
Bin Minh
DoNRE

Structures of investigated open pit mines – Hoa Binh drilling and blasting

https://naturstein.steine-erden-bayern.de/de/3/naturstein/gewinnung

Further examples:

http://en.epc-groupe.com/drilling-blasting/



Bench blasting combined with wellhole blasting

Precondition: regulated mine development as well as berm mining, as example

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Drilling: Equipment technology

http://www.tm-bohrtechnik.at/produkte/raupenbohrgeraet/raupenbohrgeraete/?L=0

http://www.sigmaplantfinder.com/product/atlas-copco-roc-d7c-11-2/

- small-sized equipment technology

- electrohydraulic drill drive
- pivoted carriage
- crawler chassis
- unlimited portably
- drill depth up to approx. 10 m
- diameter < 200 mm

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Drilling: Equipment technology

http://www.steine-und-erden.net/se401/1bohr.htm

https://www.traxxon.com/custom-solutions/

http://www.steine-und-erden.net/se399/stexpo.htm

- Large hole drilling technology
  - Electro hydraulic drill drive
  - pivoted carriage
  - crawler chassis
  - unlimited portably
  - drill depth up to > 10 m to 30 m
  - Durchmesser > 200 mm to 350 mm

Quang Long
Hop Tien
Bin Minh
DoNRE

Structures of investigated open pit mines – Hoa Binh drilling and blasting

According to the current status, the main requirements for a successful blasting are the following:

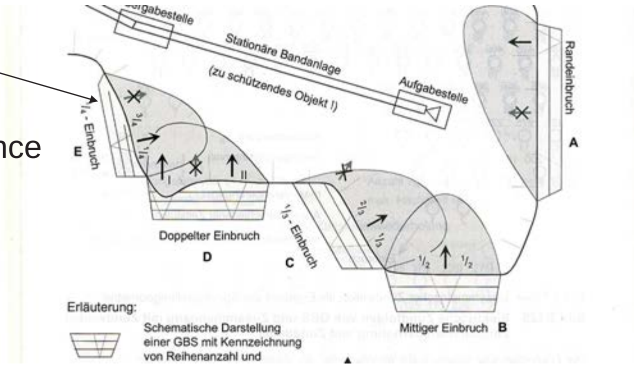
- Utilisation of an electrical ignition when optimizing the ignition angle and the cut to be created
- Delay interval regulation
- Ignition phase
- Borehole length of approx.12 m
- Load quantity of 50 to 150 kg of explosive
- Utilisation of pumped emulsion explosives

Quang Long
Hop Tien
Bin Minh
DoNRE

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Primary influence:

- Location of the cut
- Ignition angle
- Ignition sequence



Federal Ministry of Education and Research

Quang Long
Hop Tien
Bin Minh

DoNRE

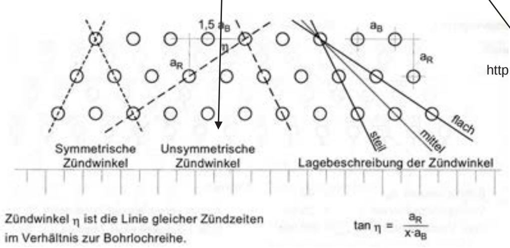
technische universität dortmund

TECHNISCHE UNIVERSITÄT DRESDEN

Leibniz Institute of Ecological Urban and Regional Development

Structures of investigated open pit mines – Hoa Binh drilling and blasting

- Ignition angle and ignition sequence



http://www.constructionphotography.com/Details.aspx?ID=17672&TypeID=1

http://schotterwerk-geiger.com/aktuell-film.htm

Federal Ministry of Education and Research

Quang Long
Hop Tien
Bin Minh

DoNRE

technische universität dortmund

TECHNISCHE UNIVERSITÄT DRESDEN

Leibniz Institute of Ecological Urban and Regional Development

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Secondary crushing:

- blasting
- manually
- mechanically

https://www.badische-zeitung.de/merdingen/mit-einem-knall-zerlegt-es-den-dicksten-knaepper--3218037.html

http://ftf.lima-city.de/

http://www.aggbusiness.com/categories/breaking-drilling-blasting/features/quarry-rock-breakers-are-an-option-when-blasting-is-not/

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Possibilities to reduce the dust exposure:

- Sprinkling of muck piles immediately after blasting
- Gentle blasting
- Reduction of drilling holes and their distances
- Optimisation of ignition sequences
- Utilisation of water-ampule stemming

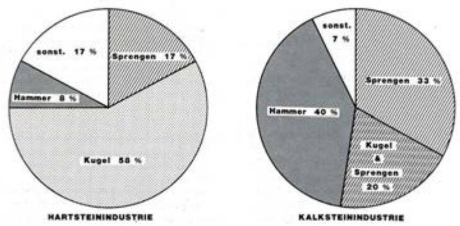
Federal Ministry of Education and Research | Quang Long Hop Tien Bin Minh | DoNRE | C&E | tu technische universität dortmund | TECHNISCHE UNIVERSITÄT DRESDEN | Leibniz Institute of Ecological Urban and Regional Development

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Feasibility Studies

Secondary crushing: high time expenditure, cost intensive, dangerous

- mechanically
- by blasting

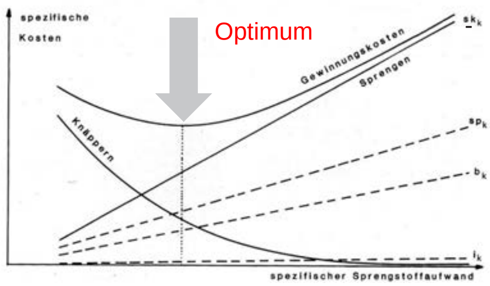


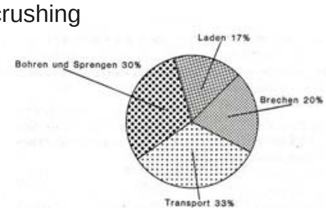
Distribution of secondary crushing processes in more than 100 quarries in Germany

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Influence of the production on total cost

- Optimisation of the production costs
- Finding the optimum between the costs for blasting and secondary crushing





Contribution to the overall result: Optimisation of the costs for drilling and blasting!

Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
C&E
tu technische universität dortmund
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Main task in the winning process:
optimisation of the drilling and blasting process

https://baunetzwerk.biz/jede-sprengung-sicher-im-griff/150/1993/101505/

- Monitoring of blasting by means of drones
- Derivation of conclusions for the optimization of ignition sequences,
- the arrangement of the specifications
- Optimisation of the blasting process

Quang Long
Hop Tien
Bin Minh
DoNRE

Structures of investigated open pit mines – Hoa Binh drilling and blasting

Main task in the extraction process:
Optimisation of the drilling and blasting process

References:

/1/ Heinze: Sprengtechnik, Anwendungsgebiete und Verfahren; Leipzig : Dt. Verl. für Grundstoffindustrie, 1993

/2/ Berlin : Bundesverb. Baustoffe - Steine und Erden: Jahresberichte / Bundesverband Baustoffe - Steine + Erden e.V.

/3/ Korak, J.: Technisch-wirtschaftliche Untersuchung der Transportbetriebsmittel unter besonderer Berücksichtigung der Transportmittel-Kombination Fahrbare-Brechanlage – Gurtbandanlage für den Transport der Haufwerke im engeren Festgestein-Tagebaubereich; Hochschulschrift , Technische Hochschule Aachen 1978

/4/ Riedel, W.: Befahrungsbericht Ostrauer Kalkwerke GmbH, Ostrau und BWH Basaltwerk Mittelherwigsdorf OHG, Mittelherwigsdorf, Termin: 29.06.2016

/5/ Aßbrock, O.: Beitrag zur Beurteilung des Sprengerfolges von Gewinnungssprengungen im Festgesteinstagebau mit Hilfe der digitalen Bildverarbeitung und -analyse

Quang Long
Hop Tien
Bin Minh
DoNRE

Challenges and opportunities of aggregate mining in Hoa Binh Province – the engineering perspective

Klaus-Dieter Oswald

The aim of the presentation was to examine identified problems of the current state of mining activities in Hoa Binh Province. In this context, structures of investigated open pit mines in Hao Binh were analysed, compared and assessed. The “Ostrauer Kalkwerke GmbH” and “BHW Basaltwerk Mittelherwigsdorf/Lausitz” served as German reference projects and benchmarks. The main parameters of the investigations in Hoa Binh Province are the exploratory and pre-processing work, the mining, extraction and processing technologies as well as marketing.

The main findings are that the observed form of “climbing and blasting” in an open cast mine is not in accordance with occupational health and safety regulations in open cast mining technology. It prevents the application of “Cleaner Production Technologies”, does not guarantee the continuous extraction of minerals and inhibits the full use of all resources (resource efficiency). One important reason for this kind of unregulated extraction is the small size of mining operations. Another reason for non-compliance is a number of large discrepancies between the approved operational design and the practical mining technology. Generally, most of the mining operators are unable to improve the mining technology and the exploratory and pre-processing works into best practice. The mining operating areas are, in fact, too small to install the necessary system of ramps, berms, slopes and benches.

Finally, an overview of Cleaner Production (CP) Technologies was given. Here the main message is that the application of CP strategy to mining is a key part of the continuous improvement process. The main aim for Vietnam should be to develop a guideline for CP in the aggregate industry, including a methodology for “Good Mining Practice” and respective management approaches.

Project MAREX –
From the idea to an international project

Đề án MAREX –
Từ ý niệm thành dự án hợp tác quốc tế

Challenges and opportunities of aggregates mining in

Hoa Binh province - the engineering perspective

Dipl.-Ing. K.-D. Oswald
Dr.-Ing. W. Riedel
Prof.-Dr. P. Schneider

Federal Ministry of Education and Research | Quang Long, Hop Tien, Bin Minh | DoNRE | 1 | C&E | tu technische universität dortmund | TECHNISCHE UNIVERSITÄT DRESDEN | Leibniz Institute of Ecological Urban and Regional Development

MAREX-Management of Mineral Resources Extraction in Hoa Binh Province

LEGAL MINING BUSINESSES
IN HOA BINH PROVINCE

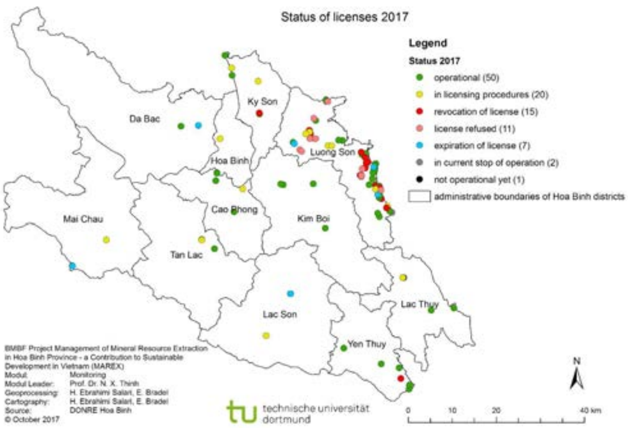
Status November 2015

Total mining operations:	**94**
Operating:	**51**
Stop of operation:	**8**
In licensing procedure:	**35**

(limestone, basalt, clay, sand)

SPONSORED BY THE Federal Ministry of Education and Research | Quang Long, Hop Tien, Bin Minh | DoNRE | 2 | C&E | tu technische universität dortmund | TECHNISCHE UNIVERSITÄT DRESDEN | Leibniz Institute of Ecological Urban and Regional Development

Structures of investigated open pit mines – Hoa Binh Comparison of all Provinces



Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
3
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

MAREX-Management of Mineral Resources Extraction in Hoa Binh Province

Assessment of the mining technology:

- Evaluation of questionnaires from 27 of the 94 open cast mining sites
- Site visit to 2 opencast mines in the framework of the workshop June 2016 in Germany
- Site visit to 12 opencast mines (quarries) in Hoa Binh in November 2016

Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
4
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

Assessment Status – Interim results

- Field Visit Report Ostrauer Kalkwerke GmbH, Ostrau and BWH Basaltwerk Mittelherwigsdorf OHG, Mittelherwigsdorf – 29.06.2016
- Field Visit Report Basalt-Actien-Gesellschaft, Parthenstein, Tagebau Großsteinberg and Ostrauer Kalkwerke GmbH, Ostrau – 10.08.2016
- Evaluation Report for the results of the questionnaires - 11/2016
- Visit of the German research team to Hanoi and Hoa Binh province 30/10/16- 30/11/16 – 30//16 – Fieldwork Report – module 2
- Field Visit Report Vietnam from 14.11.2016 – 18.11.2016; 12/201618

Federal Ministry of Education and Research · Quang Long Hop Tien Bin Minh · DoNRE · 5 · C&E · tu technische universität dortmund · TECHNISCHE UNIVERSITÄT DRESDEN · Leibniz Institute of Ecological Urban and Regional Development

Reference project – International
Ostrauer Kalkwerke GmbH, Ostrau

Explosives consumption: 360 g/m³

- **Main characteristics:**

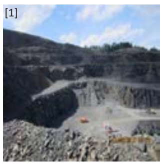
Deposits: dolomite – limestone
Reserves: about 100 years (at current output)
Annual output: approx. 300 Tm³
Mining method: underhand stoping
Burden ratio: 2:1 (2 m³ overburden to 1 m³ rock)
Exploitation: drilling and blasting
Charging: LHD-method and dump truck until processing
Extraction: approx. 90%
Products: fertiliser, filling material, road construction material
Cutting direction: south southeast (expansion area)
Mining direction: parallel benching, congruent with cutting direction

Federal Ministry of Education and Research · Quang Long Hop Tien Bin Minh · DoNRE · 6 · C&E · tu technische universität dortmund · TECHNISCHE UNIVERSITÄT DRESDEN · Leibniz Institute of Ecological Urban and Regional Development

Reference project – International
BHW Basaltwerk Mittelherwigsdorf/Lausitz

- Main parameters:

Deposits: basaltic rock
Reserves: about 15 years
Annual output: approx. 300 Tm³ / approx. 500 Tm³
(depending on demand)
Mining method: underhand stoping over berm, downwards
Exploitation: drilling and blasting, annual approach approx. 3 month
Charging: excavator and dump truck until processing, partial coveying
Main products: crushed rock, grit, aggregates
Mining direction: parallel to the cut berms (90 degree offset to the cutting direction, downwards)



[1]

Explosive consumption: 0,5 kg /m³

Quang Long
Hop Tien
Bin Minh
DoNRE
7

Structures of investigated open pit mines
Excursion of 14.11. – 18.11.2016

Montag, 14.11.2016	
8:00 - 9:30	Công ty cổ phần Sông Đà 11 Ort: Xã Hoà Sơn, H. Lương Sơn
10:00 - 12:00	Công ty TNHH Xây dựng và Thương mại Quang Long Ort: Thôn Suối Nẩy, Xã Hoà Sơn, Huyện Lương Sơn
14:30 - 17:00 PM	Công ty Cổ phần xi măng X18 Ort: Xã Ngọc Lương, huyện Yên Thủy
Dienstag, 15.11.2016	
8:00 - 12:00	AM Trung Son Cement Factory / Công ty CP tập đoàn XD và DL Bình Minh Ort: Xã Trung Sơn, huyện Lương Sơn
14:00 - 15:30	Công ty TNHH Thương mại Nam Phương Ort: Thôn Lộc Môn, xã Trung Sơn, huyện Lương Sơn
16:00 - 17:00	Công ty CP Khai khoáng Long Đạt (Khai thác đá vôi) Ort: Làng Ngành, Xã Tiến Sơn, H. Lương Sơn
Mittwoch, 16.11.2016	
8:00 - 9:30	Công ty TNHH Thành Lợi (mỏ đá Núi Chẳm) Ort: Phường Thái Bình, TP. Hòa Bình
10:00 - 11:30	Công ty TNHH MTV Quang Huy (mỏ đá núi Mực) Ort: Xã Bình Thanh, huyện Cao Phong
14:00 - 16:30	Công ty TNHH XD TM Hùng Mạnh (mỏ đá xóm Đầm) Ort: Xã Mãn Đức, huyện Tân Lạc
Donnerstag, 17.11.2016	
8:00 - 9:30	Công ty TNHH Thành Phát Ort: Xã Thành Lập, huyện Lương Sơn
10:00 - 11:30	Công ty TNHH MTV đầu tư xây lắp và thương mại 36 - xí nghiệp vật liệu xây dựng 897 Ort: Xóm Sòng. Xã Thành Lập, huyện Lương Sơn
14:30 - 16:30	Công ty CP Thành Hiếu Ort: Xã Trung Sơn, huyện Lương Sơn

Hop Tien
Bin Minh
DoNRE
8

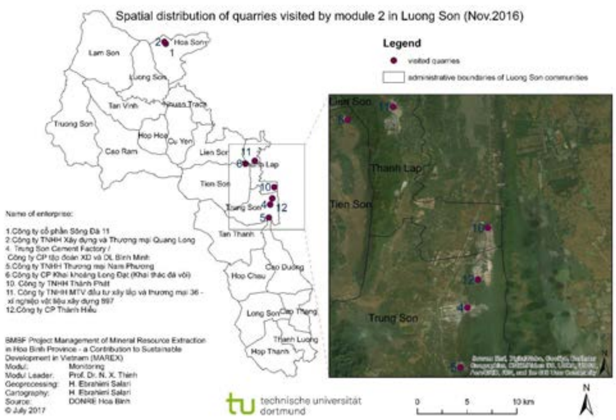
Structures of investigated open pit mines – Hoa Binh Main parameter

Ser. No. internally	annual extraction Tm³ 2015	number of staff mining	explosive consumption kg / m³	diesel fuel l / year	energy demand kwh/year	water consumption	mining regime regular/ uncontrollable	safety drilling and blasting
1.	187 basalt	20	0,4 kg/m³	272 Tl	2,7 m	no information	regularly	yes , about berms
2.	185 basalt	20	0,28 kg/m³	240 Tl	1,5 m	no information	no information	no information
3.	86 Tt limestone	50	0,37 kg/t	no information	no information	720 l/year	no information	no information
4.	1.114,2 Tt limestone	26	0,167 kg/m³	30 Tl	10 T; only mining	20 m³/day	regularly	yes, via berms
5.	187 limestone	30	0,63 kg/m³	180 Tl	2,2 m (max.)	20…30 m³/day	uncontrollably	no safety
6.	93Tm³ 2016 (?) limestone	26	0,24 kg/m³	48 Tl	1,44 m	7 m³/day (consumption)	uncontrollably	no safety
7.	44,6Tm³ limestone	k.A.	0,18 kg/m³	55Tl	2,7 m	12 m³/day (consumption)	uncontrollably	no safety
8.	44 Tm³ limestone	13	0,16 kg/m³	48 Tl	1,9 m	150 m³/Monat spring water	partly controlled, about berms	yes , via berms
9.	100 Tm³ limestone	12	0,17 kg/m³	100 Tl	not comparable	9 m³/day	partly controlled, about berms	yes , via berms
10.	40 Tm³ limestone	12	0,075 kg/m³ (?) high proportion of blocks (20 %)	120 Tl	480 T	20 m³/month	mining regime is planned, but not implemented	no safety
11.	105,8 Tm³ limestone	20	0,1…0,2 kg/m³	66 Tl	425,04 T	no information	partly controlled, about berms	yes, via berms
12.	47 Tm³ limestone	24	0,31 kg/m³	60 Tl	2,7 m	4…5 m³/day	regularly	yes, via berms
13.*)	370 Tm³ limestone	16	0,36 kg/m³	520 Tl	2,3 m	24 m³/day	according to operating plan	yes, stope height 15…18 m

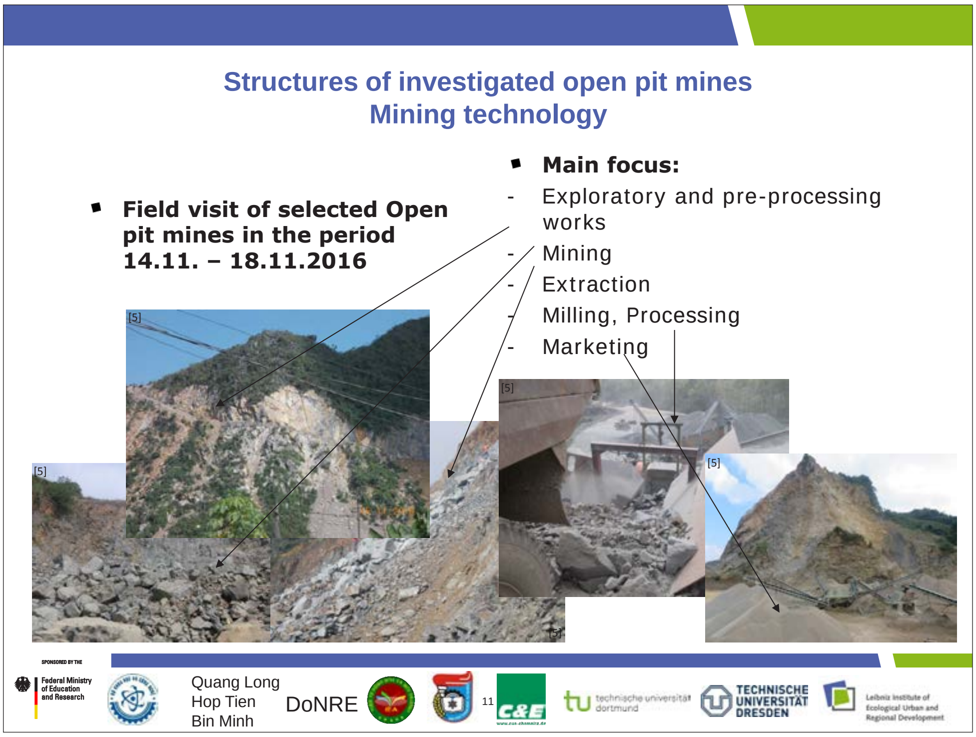
*) Comparison Kalkwerk Ostrau

SPONSORED BY THE Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
9

Structures of investigated open pit mines – Hoa Binh International comparison



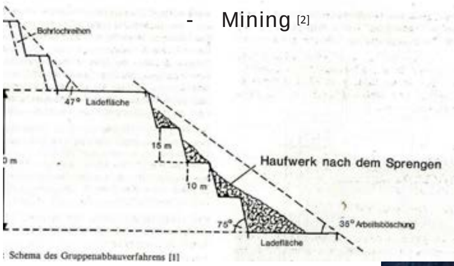
SPONSORED BY THE Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
10


Structures of investigated open pit mines
Mining technology
Main focus:
- Exploratory and pre-processing works
- Mining
- Extraction
- Milling, Processing
- Marketing
Field visit of selected Open pit mines in the period 14.11. – 18.11.2016
[5]
[5]
[5]
[5]
Quang Long
Hop Tien
Bin Minh
DoNRE
11
TECHNISCHE UNIVERSITÄT DRESDEN


Structures of investigated open pit mines
Field visit 14.11. – 18.11.2016
- Exploratory and pre-processing works
[5]
[5]
[5]
- Construction of access roads and ramps
- Build up of slopes and berms (LHD technics)
- (German: Aus-und Vorrichtung)
Quang Long
Hop Tien
Bin Minh
DoNRE
12
TECHNISCHE UNIVERSITÄT DRESDEN

Structures of investigated open pit mines
Field visit 14.11. – 18.11.2016

- Mining [2]



[5] Preparatory works for extraction

[5]

Quarries:

- Underhand stoping (bench working)
- Group-extraction method

Structures of investigated open pit mines
Field visit 14.11. – 18.11.2016

- Extraction

[5]

[5]

- **Drilling**
- **Blasting**
- **Loading**
- **Hauling**

Sponsored by the Federal Ministry of Education and Research | Quang Long Hop Tien Bin Minh | DoNRE | 14 | C&E | technische universität dortmund | Technische Universität Dresden | Leibniz Institute of Ecological Urban and Regional Development

Structures of investigated open pit mines

Field visit 14.11. – 18.11.2016

- Marketing

  - Sales, Pricing
  - Distribution
  - Product marketing
  - Transportation

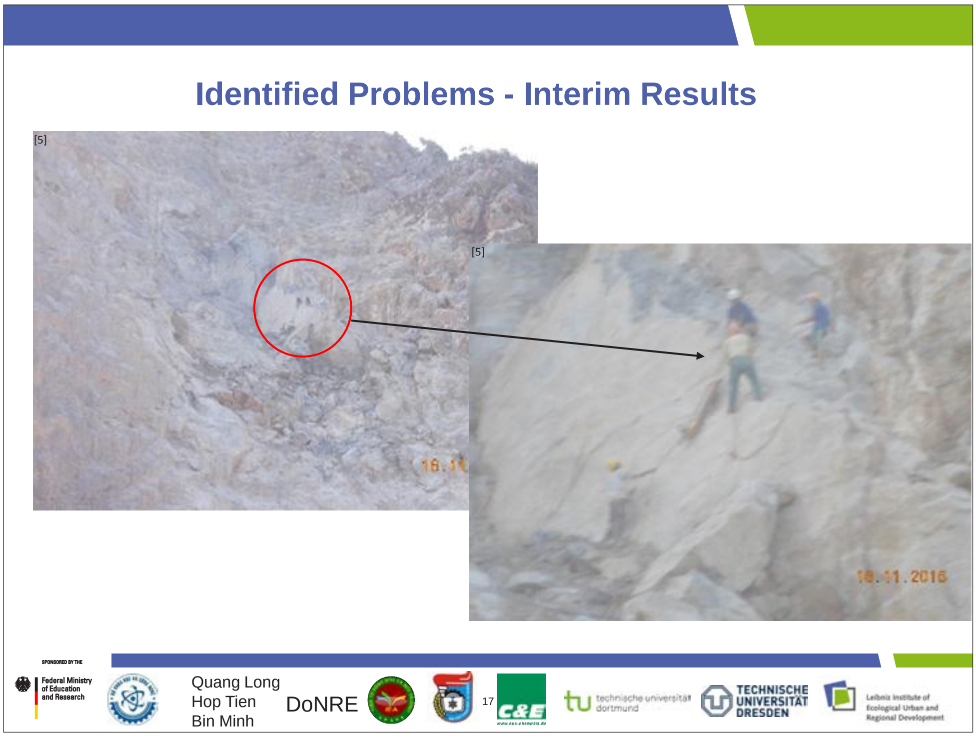
[5]

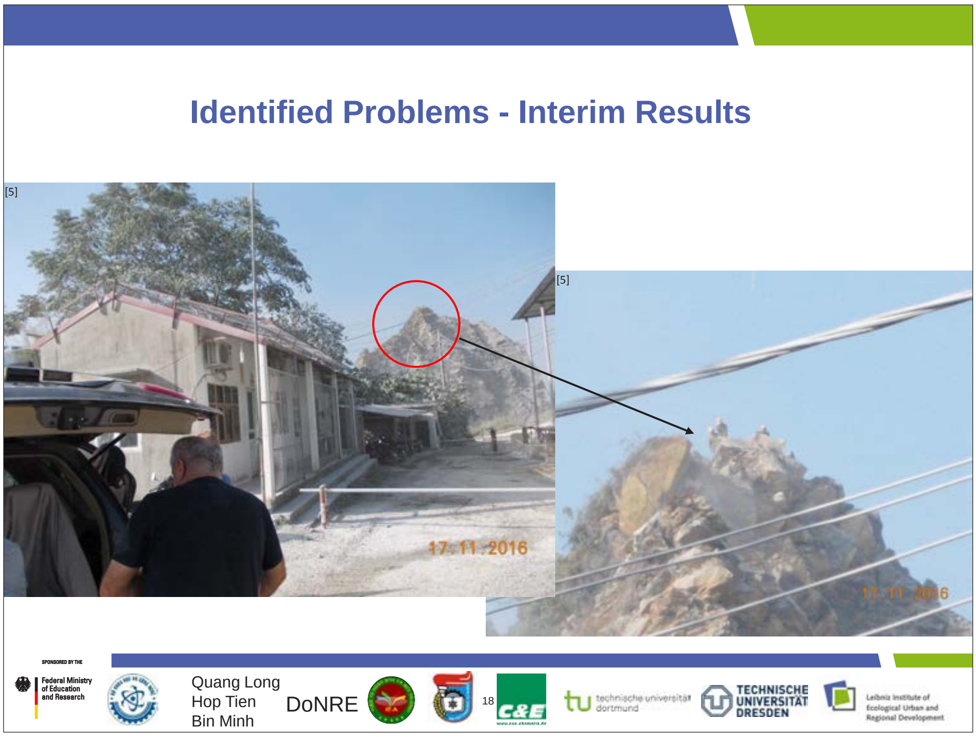
[5]

[5]

Identified Problems - Interim Results

- Almost each visited open cast mine shows a non-compliance with the state-of-the-art open cast mining technologies
- Instead of a regular technology with exploratory and pre-processing works for the installation of slopes, berms and ramps, is carried out a dangerous and risky „alpinistic“ exploitation without the guarantee of continous mineral extraction.
- This kind of „climbing and blasting“exploitation is extremely dangerous for the involved workers, ecspecially if they have to transport the drilling equipment and explosives uphill without any protection equipment for mountaining.


Identified Problems - Interim Results
[5]
[5]
18.11.2016
Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
17
C&E
tu technische universität dortmund
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

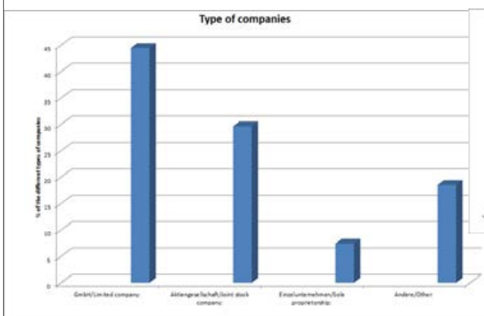

Identified Problems - Interim Results
[5]
[5]
17.11.2016
17.11.2016
Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
18
C&E
tu technische universität dortmund
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

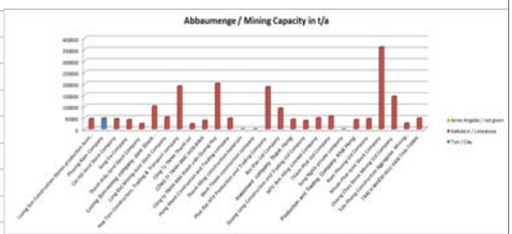
Conclusions - Interim Results

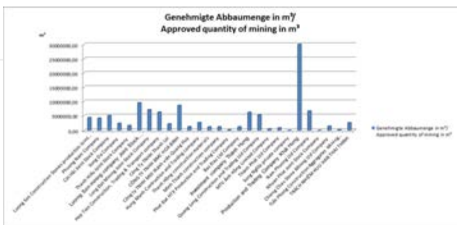
- This kind of „climbing and blasting“ in an open cast mine is not in accordance with the occupational health and safety regulations in open cast mining technology
- It prohibits the application of „Cleaner Production Technologies“ and does not guarantee the continous extraction of the minerals and prevents the full use of all resources (resource efficiency).
- One important reason for this kind of uncontrolled extraction is the size of the mining operation area (too small)

Quang Long
Hop Tien
Bin Minh
DoNRE
19

Interim Results



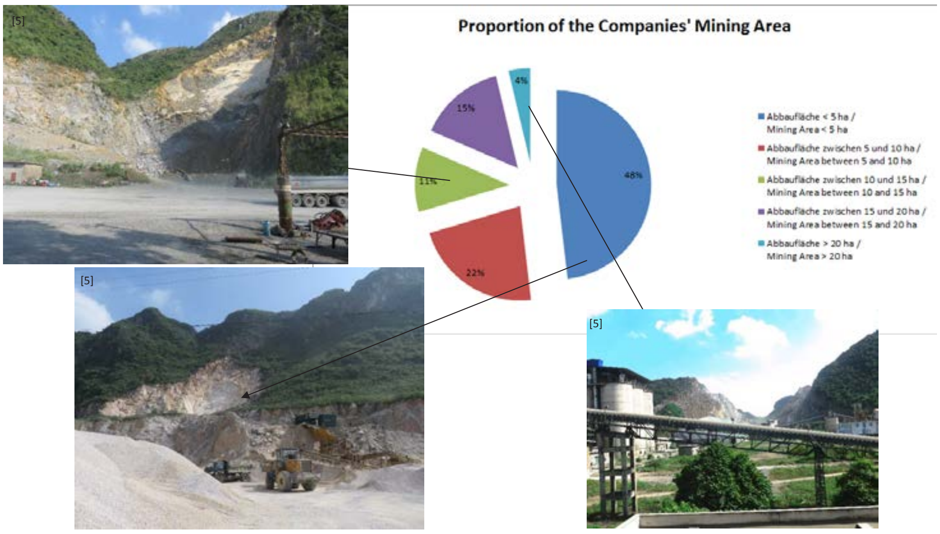




- Clay 1
- Limestone 23
- Basalt 3

Quang Long
Hop Tien
Bin Minh
DoNRE
20

Interim Results



Quang Long
Hop Tien
Bin Minh
DoNRE
21

Structures of investigated open pit mines – Hoa Binh International comparison

According to § 51 Art. 1 of the German Federal Mining Act (BBergG), survey, recovery and treatment companies, which are supervised by the mining authority, may be erected, managed and stopped only on the basis of operational plans. These include, among other things, regulations for the rehabilitation of opencast mining.

Quang Long
Hop Tien
Bin Minh
DoNRE
22

Structures of investigated open pit mines – Hoa Binh International comparison

1. Legal preconditions in Germany - Duties of the Mining Authority

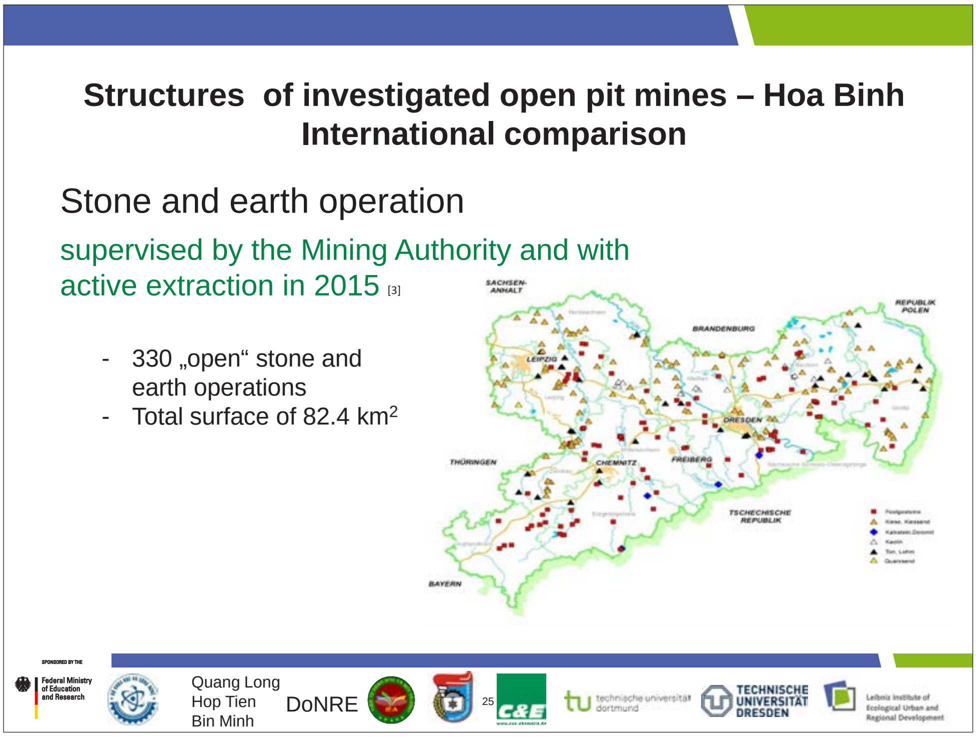
1. **Granting mining permits:** Permission – Approval – Mining property
2. Surveying **field and mining royalties**
3. **Approval of operating plans** (search, framework, main, special and final operating plans)
4. Monitoring of **operational safety**
5. **End of the mining supervision after termination of mining**
6. **Environmental, occupational health and safety** in the mining sector
7. **Financing** of the **restoration mining**
8. **Emergency response** in underground cavities, dumps and former opencast mines (falls within police authority), consultation of other authorities, guidance of the cavity map.

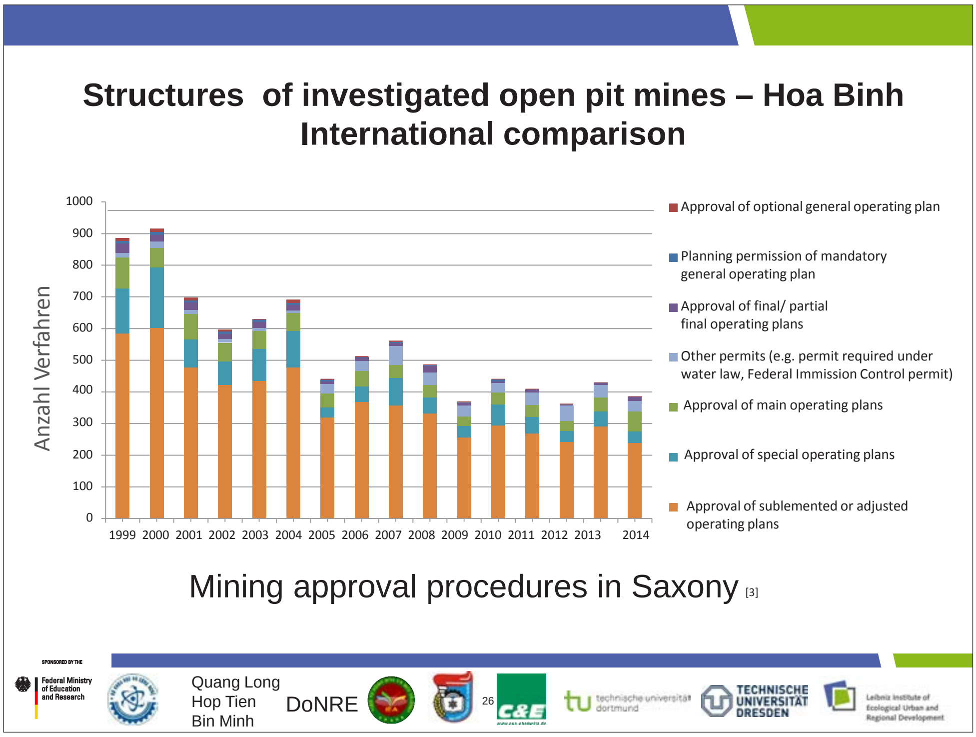
Structures of investigated open pit mines – Hoa Binh International comparison

The Federal Mining Act differentiates the types of operational plans

- Main operational plans,
- Optional general operating plan
- Compulsory general operating plan
- Final operating plans,
- Special operating plans,
- Collaborative operating plans.

Predetermined mining technologies are specified in main operational plans.


Structures of investigated open pit mines – Hoa Binh
International comparison
Stone and earth operation
supervised by the Mining Authority and with
active extraction in 2015 [3]
- 330 „open“ stone and earth operations
- Total surface of 82.4 km²
SACHSEN-ANHALT
BRANDENBURG
REPUBLIK POLEN
LEIPZIG
DRESDEN
THÜRINGEN
CHEMNITZ
FREIBERG
TSCHECHISCHE REPUBLIK
BAYERN
Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
25
technische universität dortmund
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development


Structures of investigated open pit mines – Hoa Binh
International comparison
Anzahl Verfahren
1000
900
800
700
600
500
400
300
200
100
0
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Approval of optional general operating plan
Planning permission of mandatory general operating plan
Approval of final/ partial final operating plans
Other permits (e.g. permit required under water law, Federal Immission Control permit)
Approval of main operating plans
Approval of special operating plans
Approval of sublemented or adjusted operating plans
Mining approval procedures in Saxony [3]
Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
26
technische universität dortmund
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

Structures of investigated open pit mines – Hoa Binh International comparison

Gross production of stone and earht

Operations supervised by the Mining Authority 2014 [3]

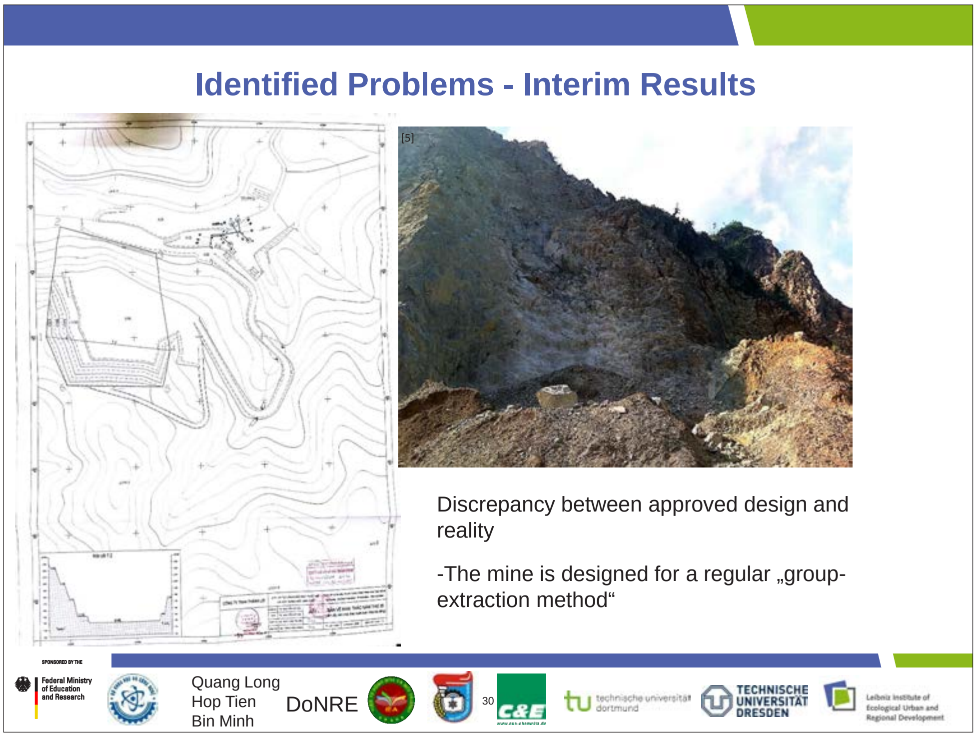
Type of resource	Gross Production in 2014 (million t)	Quantity of extracting companies in 2014
Solid rock	19.76	70
Gravel and gravelly sand	14.11	101
Kaolin	1.60	11
Clay, brick earth	1.03	12
Lime and dolomite	0.54	3
Silicia and foundry sand	0.044	1
Special clay	0.32	8
Total	**37.40**	**206**

282 Tt/a

Identified Problems - Interim Results

- Another reason for non-compliance are huge discrepancies between the approved operational design and the practiced mining technology
- Some companies have very well executed design documents which are approved by the responsible and competent authorities. These documents consider the necessary structures of a open pit mine like ramps, berms and slopes, but in the reality the mines are constructed with much more simple structures.
- Consequently the works supervision which has to be done by the responsible supervisory authority is not sufficient or is uncompletely because of staff shortages


Identified Problems - Interim Results
[5]
[5]
15.11.2016
Discrepancy between approved design and reality
- Access road with ramps, berms and lower loading area
SPONSORED BY THE
Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
29
C&E
tu technische universität dortmund
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

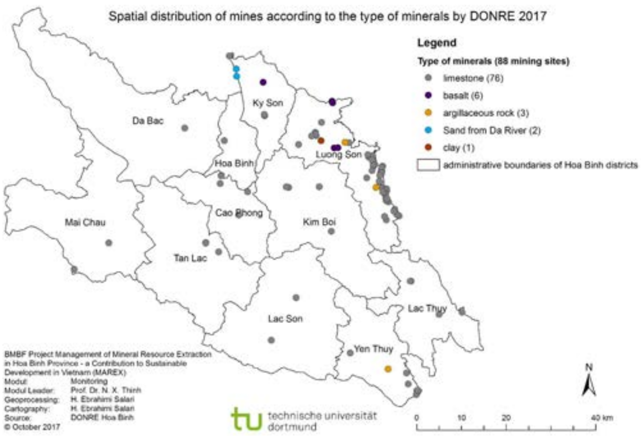

Identified Problems - Interim Results
[5]
Discrepancy between approved design and reality
-The mine is designed for a regular „group-extraction method“
SPONSORED BY THE
Federal Ministry of Education and Research
Quang Long
Hop Tien
Bin Minh
DoNRE
30
C&E
tu technische universität dortmund
TECHNISCHE UNIVERSITÄT DRESDEN
Leibniz Institute of Ecological Urban and Regional Development

Conclusions - Interim Results

- Generally, most of the mining operators are not able to improve the mining technology and the exploratory and pre-processing works into a Best Practice, because the mining operating areas are too small to install the needed system of ramps, berms, slopes and benches.
- The main reason for this situation is the award of licenses which is obviously not controlled sufficíently.

Quang Long
Hop Tien
Bin Minh
DoNRE
31

Structures of investigated open pit mines – Hoa Binh Comparison of entire Province



Quang Long
Hop Tien
Bin Minh
DoNRE
32

Conclusions - Interim Results

- The high number of licenses prevent continuous mining and extracting technology.
- This leads to high extraction losses, since a strictly controlled exploitation is not feasible due to the too narrow field limits and thus the large part of the resources are blocked.
- Therefore, the application of „Cleaner Production Technologies“ is feasible to a limited extent at the moment only, and can be implemented only in certain process steps like drilling, blasting, crushing and sieving as well as hauling and transport.

Conclusions - Interim Results

- The small scale mining operations (50% less then 5 ha) leads to a small annual extraction volume (less then 50 Tm³/a; German (Saxony) average appr. 300 Tm³/a).
- This amount is not sufficient to generate budget for investments in technology and equipment. Further, the approved quantities suggest a relatively short operation time of the quarries.
- The mining operators reported to have big difficulties to receive loans from the banks.
- Due to huge discrepancies between approved design of the operational plan and the practiced mining technology as well as the insufficient supervision, the operation requires significant improvement.

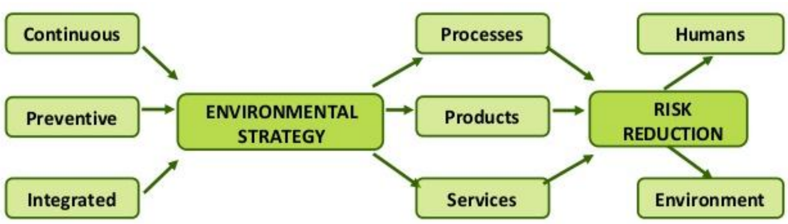
Outlook

- ***Cleaner production (CP)*** means the continuous application of an integrated, preventive environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment.
- The application of CP strategy to mining is a key part of the continuous improvement process aimed at increasing resource use and operational efficiency over the entire life cycle, and continuously reducing waste disposal and rehabilitation requirements.

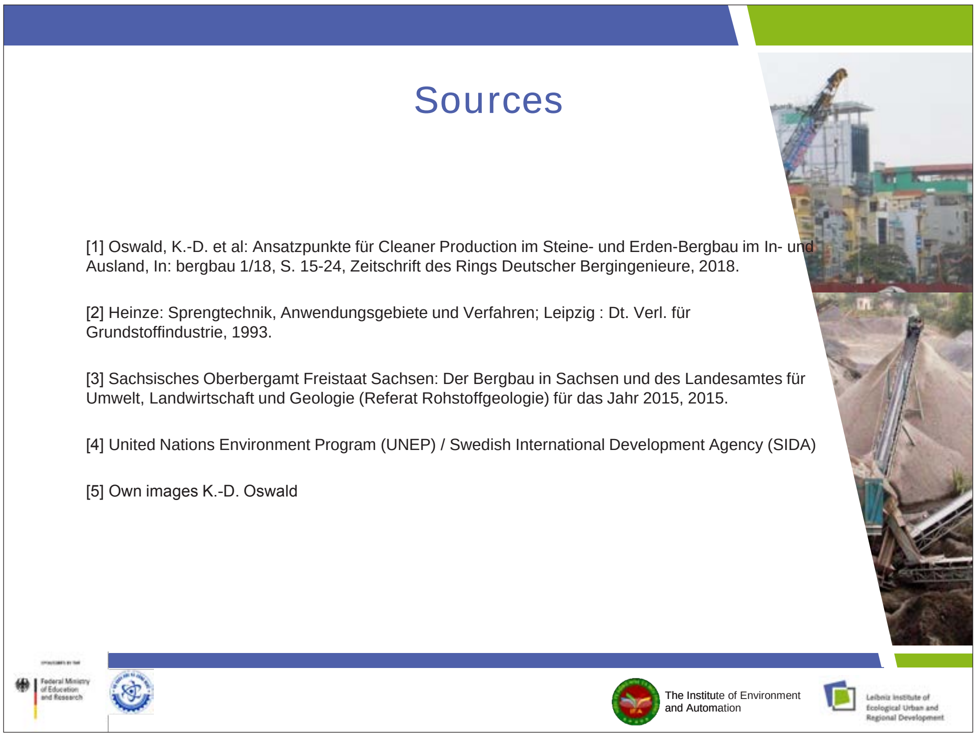
Quang Long
Hop Tien
Bin Minh
DoNRE
35

Outlook

- Overall scope is the development of a guideline for CP in the aggregates industry, including a methodology for a „Good Mining Practice“ and the respective management approaches. [4]



Quang Long
Hop Tien
Bin Minh
DoNRE
36


Sources
[1] Oswald, K.-D. et al: Ansatzpunkte für Cleaner Production im Steine- und Erden-Bergbau im In- und Ausland, In: bergbau 1/18, S. 15-24, Zeitschrift des Rings Deutscher Bergingenieure, 2018.
[2] Heinze: Sprengtechnik, Anwendungsgebiete und Verfahren; Leipzig : Dt. Verl. für Grundstoffindustrie, 1993.
[3] Sachsisches Oberbergamt Freistaat Sachsen: Der Bergbau in Sachsen und des Landesamtes für Umwelt, Landwirtschaft und Geologie (Referat Rohstoffgeologie) für das Jahr 2015, 2015.
[4] United Nations Environment Program (UNEP) / Swedish International Development Agency (SIDA)
[5] Own images K.-D. Oswald
Federal Ministry of Education and Research
The Institute of Environment and Automation
Leibniz Institute of Ecological Urban and Regional Development

Conclusions and outlook

Georg Schiller, Tamara Bimesmeier, Petra Schneider

The MAREX project explores the environmental impact of rapid urbanization. Scientific investigations focus on the building industry in the context of local finite resources, taking into consideration several related factors such as the extraction and processing of raw materials, transportation, use in the built environment as well as potential recycling of construction and demolition waste. The Metropolitan region of Hanoi and Hoa Binh Province provide an example of a comprehensive model for broader application both within Vietnam and elsewhere. Currently, the government's main strategic priority is to develop Hanoi City (current population: 6.6 million) into a large-scale capital city and an important hub for the political-administrative interface as well as for cultural, educational, scientific and economic activities and international trade. This strategy is being supported by the urban hinterland, such as nearby Hoa Binh Province, by providing necessary raw mineral resources. Such rapid urban development has had serious negative repercussions on the environment of such provinces.

The function of cities, the urban surroundings and rural areas form an integrated system. In growing regions we generally find increased demand on land use. As land is a limited resource, this leads to increasing pressure between competing or conflicting uses. Such pressures are reflected, among other things, in rising land and property prices as well as intensified land use. The urban hinterland and the rural area are not only resources for cities, they also affect the development paths of urban centres. Sustainable regional development, in particular resource-efficient land management, requires more cross-sectoral and inter-municipal approaches and implementations. This kind of urban metabolism and urban-rural interactions can be described by means of Material Flow Analysis (MFA) in order to quantify the respective environmental impacts. The MFA method addresses the dependencies and interdependencies within the nexus of the city, the urban surroundings and rural areas, in terms of land and material flow management as well as material cycles. A further aim of MAREX is to propose various long-term options for future development based on resource-efficiency and the circular economy. In addition, the goal is to relieve the burden on land resources and at the same time to achieve a higher regional added value for the value chain *aggregate mining – transport – distribution – construction site – built environment*.

Cleaner Production (CP) in aggregate mining aims to improve environmental protection and reduce ecological risks by encouraging positive economic and social factors while avoiding production factors with negative environmental impacts. CP is an important method for the development of cycle management at the level of strategic company positioning. CP provides a measure of product-integrated environmental protection (i.e. resource efficiency) as well as production-integrated environmental protection. General applications of CP are already practiced in Vietnam for rock consumption in civil construction projects. The Mineral Law of 2010 constitutes the main regulatory framework for mineral extraction in the country. The regulatory framework for environmental assessment is the obligation to conduct an Environmental Impact Assessment (EIA) and environmental monitoring. Further, it requires the conclusion of environmental protection measures, which can be based on environmental modeling created during the approval procedure. CP measurement will encompass all engineering and environmental factors in order to promote the integration of product quality, environmental factors as well as occupational health and safety.

At a global scale, there are significant gaps in our knowledge of the interaction of urban-rural links in discussions regarding regional sustainability. In the long term we need measurable indicators that can map regional development in a more specific way and offer options to integrate the planning and management of cities, urban areas and rural areas.

MAREX Publication Series

– The final results of the project –

Issue 1: **Management of mineral resource extraction in Hoa Binh Province, Vietnam**
Seven recommendations for responsible construction aggregates mining and contributions to sustainable urban and regional development
Bernhard Müller, Georg Schiller, Peter Wirth, Tamara Bimesmeier, Anh Minh Vu, Nguyen Xuan Thinh, Haniyeh Ebrahimi-Salari, Paulina Schiappacasse, Klaus-Dieter Oswald, Wolfgang Riedel, Petra Schneider

Issue 2: **Monitoring of mineral resource extraction and analyzing its impacts on the environment and land cover/land use in Hoa Binh Province**
Nguyen Xuan Thinh, Haniyeh Ebrahimi-Salari

Issue 3: **Technical solutions for mining and processing of aggregates and the mining sites after-use**
A Cleaner Production Guideline for Vietnam
Klaus-Dieter Oswald, Petra Schneider, Wolfgang Riedel

Issue 4: **Cleaner production, mining optimizing approaches and material flow analysis**
MAREX Workshop, Hoa Binh, Vietnam, November 2017
Tamara Bimesmeier, Pham Thi Viet Anh, Klaus Dieter Oswald, Wolfgang Riedel, Georg Schiller, Petra Schneider

Issue 5: **Regional material flow analysis**
A concept for balancing supply and demand of construction minerals for regions using the example of Hanoi and the hinterland province Hoa Binh
Georg Schiller, Tamara Bimesmeier

Issue 6: **The economic impacts of construction aggregate mining on regional development**
The case of Hoa Binh Region, Vietnam
Paulina Schiappacasse, Bernhard Müller, Peter Wirth

Issue 7: **Planning for the responsible extraction of natural aggregates**
The case of the Hanoi Metropolitan Area
Bernhard Müller, Paulina Schiappacasse

Issue 8: **Legal framework for aggregates mining in Vietnam from the perspective of environmental protection**
Anh Minh Vu, Juliane Albrecht, Denise Füssel

Issue 9: **The MAREX Alliance**
A Business-Policy Interface for the responsible management of mineral aggregates in Hoa Binh Province, Vietnam
Bernhard Müller, Paulina Schiappacasse, Peter Wirth, Anh Minh Vu

All results and information: www.marex-project.de

This booklet is a result of MAREX project:
Management of Mineral Ressource Extraction in Hoa Binh Province –
A Contribution to Sustainable Development in Vietnam

MAREX Partners in Germany

Leibniz Institute of
Ecological Urban and
Regional Development

TECHNISCHE
UNIVERSITÄT
DRESDEN

technische universität
dortmund

C&E · Consulting und
Engineering GmbH

SPONSORED BY THE

Federal Ministry
of Education
and Research

MAREX Partners in Vietnam

The Institute of
Environment and
Automation

VNU University of Science,
Vietnam National
University

SPONSORED BY THE

Ministry
of Science and
Technology

SUPPORTED BY THE

People's Committee
of Hoa Binh Province,
Vietnam

ISBN 978-3-933053-37-4