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

MAREX Publication Series – Issue 4
Cleaner production, mining optimizing approaches and material flow analysis

MAREX Workshop, Hoa Binh, Vietnam, November 2017
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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

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


MAREX Workshop

Cleaner Production, Mining Optimizing and Material Flow

Hoa Binh, Vietnam
November 01 - 02, 2017

Topics

T1 Sustainable mining activities in Hoa Binh Province - the MAREX framework
T2 Basic information on methods and concepts
T3 Planning oriented strategic MFA
T4 Operational Material Flow Management
T5 Strategies towards effective mining
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

Participants

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

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
Construction aggregates and the Sustainable Development Goals

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 economic 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

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
Study Area


land use change in Hanoi. 1996

MAREX – Workshop Hoa Binh November 2017 | The MAREX framework

Land use change in Hanoi. 2014


Aggregates extraction in Hoa Binh

Source: Source: http://example.com

Diagram: Extraction of Mineral Aggregates in Hoa Binh Province, Vietnam

- Source: [Source: http://example.com]
- Diagram: [Diagram: Extraction of Mineral Aggregates in Hoa Binh Province, Vietnam]
Mining Site – Luong Son District

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

- Aggregates Extraction
- Natural Protection
- Agriculture
- Residential areas
- Tourism

Licensing of aggregates mining

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

Data Source: DoNRE
Chart: Wirth/IOER
Importance of Aggregate Mining in Hoa Binh Regional Economy

- Strong economic growth in provincial economy ...% annual average

- Economic recession in the quarrying sector

In the mining sector aggregates are dominating

BUT

Only small and medium sized companies (except 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

- action-oriented
- flexible
- structured
- participatory
- consultative
- transdisciplinary
- interdisciplinary
- comprehensive
Integrated Regional, Land-use, Construction planning

Capacity planning mining
Building material production

Settlement planning
Infrastructure planning
Green Building

Circular economy

Waste management
Topic 2

Basic information on methods and concepts
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

MAREX Workshop

Basic information on methods and concepts

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November 01 - 02, 2017

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
Objective 1
Concepts, methods, sustainable mining

Objective 2
Future demand/supply

Objective 3
Assessment/optimizing strategies

Objective 4
Technologies and Management

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 |
**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
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

**material amount**
- flows, accumulated flows
  + complete
  - limits of differentiation

---

**Top down**

population

\[ \times \]

economic figures

consumption per person

\[ \leftrightarrow \]

economic figures

consumption per person
**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
- material amount
  - flows, accumulated flows
- + complete
- - limits of differentiation

**Bottom up**
- + 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)
- 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**

\[ \text{MCI} \times \text{Metric figure} = \text{Mass} \]

**Roads**
- Specific mass (tons per m\(^2\))
- Metric flow / stock (m\(^3\))
- Absolute mass (tons)

**Buildings**
- Specific mass (tons per m\(^2\))
- Metric flow / stock (m\(^3\))
- Absolute mass (tons)

**Material flow (t\(_i\)) = Stock (t\(_i\)) - Stock (t\(_i-1\))**
Spatial boundaries

Case study area

Source: own illustration

Source: diysolarpanelsv.com and alarmy.de
Material flow analysis (Inventory) & Life cycle Assessment

Source: own illustration
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


MAREX Workshop
Background Terms and Definitions

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

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
Turning a Value Chain into a Value Circle

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.
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.

**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.

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**Porter value chain for mining**

<table>
<thead>
<tr>
<th>Michael Porter model</th>
<th>Inbound logistics</th>
<th>Operations</th>
<th>Outbound logistics</th>
<th>Marketing and sales</th>
<th>Service</th>
<th>Divest</th>
<th>Margins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining value chain</td>
<td>Locate</td>
<td>Value</td>
<td>Establish</td>
<td>Transport</td>
<td>Benefit</td>
<td>Marketing</td>
<td>Divest</td>
</tr>
<tr>
<td>Supporting activities</td>
<td>Mineral resource management</td>
<td>Financial management</td>
<td>Procurement/logistics</td>
<td>Asset/maintenance management</td>
<td>Research and development</td>
<td>Human resource management</td>
<td>Risk management</td>
</tr>
</tbody>
</table>

Source: [The Journal of the South African Institute of Mining 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.

Circular economic models

- A circular economy is restorative and regenerative by design,
- aims to keep products, components, and materials at their highest utility and value at all times.
Circular economic models

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]
**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.

![Resource efficiency diagram](http://jpovaska.com)

**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.

![Resource productivity diagram](http://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

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

Eco-Design and Eco-Labeling

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.umweltbundesamt.de/themen/wirtschaft-konsum/produkte/oekodesign](https://www.umweltbundesamt.de/themen/wirtschaft-konsum/produkte/oekodesign)
Eco-innovation

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

This means developing products, techniques, services and processes that reduce CO₂ 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 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.
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.

Sources

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

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
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

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**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
Planning-oriented

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

Integrated planning
Involvement of stakeholders
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
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

Focus of MFA in MAREX
Model components

Supply → Demand

Licensed capacities
Construction activities

? supply
demand

Case study area

Source: own illustration
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

Register of legal Mining businesses
Hoa Binh Province (state 2015)

<table>
<thead>
<tr>
<th>#</th>
<th>Date of approval</th>
<th>License No.</th>
<th>Name of business</th>
<th>License period (years)</th>
<th>Type of mineral</th>
<th>Mine reserve (t)</th>
<th>Max. annual output (t)</th>
<th>Operating area (ha)</th>
<th>Site location - commune</th>
<th>Licensing agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1998-12-14</td>
<td>x</td>
<td>x</td>
<td>30</td>
<td>clay</td>
<td>720,000</td>
<td>24,000</td>
<td>4</td>
<td>xã Yên Trị</td>
<td>MoNRE</td>
</tr>
<tr>
<td>2</td>
<td>1998-12-14</td>
<td>x</td>
<td>x</td>
<td>30</td>
<td>limestone</td>
<td>2,550,000</td>
<td>85,000</td>
<td>3.7</td>
<td>xã Ngọc Liên</td>
<td>MoNRE</td>
</tr>
<tr>
<td>3</td>
<td>1999-06-18</td>
<td>x</td>
<td>x</td>
<td>22</td>
<td>limestone</td>
<td>11,263,854</td>
<td>552,227</td>
<td>16</td>
<td>xã Tân Vinh</td>
<td>People's Committee HB</td>
</tr>
<tr>
<td>4</td>
<td>2002-05-20</td>
<td>x</td>
<td>x</td>
<td>23</td>
<td>limestone</td>
<td>4,699,800</td>
<td>287,210</td>
<td>11</td>
<td>xã Thành Lập</td>
<td>People's Committee HB</td>
</tr>
</tbody>
</table>

...
## Register of legal Mining businesses

**Hoa Binh Province (state 2015)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Date of approval</th>
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<th>License period (years)</th>
<th>Type of mineral</th>
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<th>Operating area (ha)</th>
<th>Site location - commune</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1998-12-14</td>
<td>x i</td>
<td>30</td>
<td>Limestone</td>
<td>212.000</td>
<td>24.000</td>
<td>4</td>
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<td>MoNRE</td>
</tr>
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<td>2</td>
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<td>30</td>
<td>Limestone</td>
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<td>3,7</td>
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<td>MoNRE</td>
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<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

### Assumptions:
- Considering all licensed capacities in reference year 2015
- No additional licenses in the future

### Licensed mine reserves – annual capacities

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

\( i = \text{license no.} \)
Licensed Capacities (Supply)
Hoa Binh Province (state 2015)

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
Mining Masterplan [1]
Short-term demand calculation for Hoa Binh

According to the
- average of construction materials per capita
- social investment
- retrospective growth consumption

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
Mining Masterplan [1]
Short-term demand calculation for Hoa Binh

Mining Masterplan [1]
Short-term demand calculation for Hoa Binh

- Hoa Binh total
- Hanoi total
- Total demand covered by Hoa Binh = (1) + (2b)

(2b) Hanoi demand covered by Hoa Binh (= 35% of Hanoi total)


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
Supply and demand
Licensed quantities – Mining Masterplan

[1] Exploration and exploitation planning and use of three kinds of minerals as common building materials
Supply and demand
Licensed quantities – Mining Masterplan

Problem: short term demand figures

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

Long-term demand estimation

Top-down

- Total population Hoa Binh
- Consumption per capita in Vietnam

- No growth in consumption
- High growth in consumption (polin. regression)
- Weak growth in consumption (lin. regression)
Long-term demand estimation
Top-down

![Graph showing demand for mineral building materials in Hoa Binh from 2006 to 2050 for different scenarios.]

- No growth in consumption
- Weak growth in consumption
- High growth in consumption

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

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
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

Typical Vietnamese housing types

Permanent housing
  - Tubehouses
  - Apartment block / Hotel
Detached house
Semi-permanent housing
  - Semi-permanent dwellings
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
- Provincial Road
- District Road
- Commune Road
- Urban Road
  - Arterial
  - Collector
  - Local Street

Bottom-up calculation model

\[
\text{Material flow (t)} = \text{Stock (t)} - \text{Stock (t-1)}
\]

\[
\text{MCI} \times \text{Metric figure} = \text{Mass}
\]

Roads

Specific mass (tons per m²) \times \text{Metric flow / stock [m²]} = \text{Absolute mass [tons]}

Buildings

Specific mass (tons per m²) \times \text{Metric flow / stock [m²]} = \text{Absolute mass [tons]}
Material composition Indicators (MCI) of common pavement types in Vietnam

<table>
<thead>
<tr>
<th>Material Type</th>
<th>MCI Value (kg/m² road surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Concrete high class - BTN</td>
<td>[1500, 1000, 500, 0]</td>
</tr>
<tr>
<td>Asphalt Concrete low class - BTN</td>
<td>[1500, 1000, 500, 0]</td>
</tr>
<tr>
<td>Bitumen Treatment Pavement - DDN</td>
<td>[1500, 1000, 500, 0]</td>
</tr>
<tr>
<td>Concrete Pavement - BTXM</td>
<td>[1500, 1000, 500, 0]</td>
</tr>
<tr>
<td>Aggregate crushed stone - CP</td>
<td>[1500, 1000, 500, 0]</td>
</tr>
<tr>
<td>Soil - Đất</td>
<td>[1500, 1000, 500, 0]</td>
</tr>
</tbody>
</table>

Bottom-up calculation model

Roads

Flow = \( \Delta m^2 \) road surface * MCI

<table>
<thead>
<tr>
<th>Length road network [m]</th>
<th>Width [m]</th>
<th>Pavement types, road classes [m, %]</th>
</tr>
</thead>
</table>
Bottom-up calculation model

**Roads**

Flow = \( \Delta m^2 \text{ road surface} \times \text{MCI} \)

<table>
<thead>
<tr>
<th>Length road network [m]</th>
<th>Width [m]</th>
<th>Pavement types, road classes [m, %]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistical data</td>
<td>Standards</td>
<td>Expert knowledge, standards</td>
</tr>
</tbody>
</table>

Past  | Today  | Future  

### Roads - Metric figures

Flow = \( \Delta m^2 \text{ road surface} \times \text{MCI} \)

<table>
<thead>
<tr>
<th>Length road network [m]</th>
<th>Width [m]</th>
<th>Pavement types, road classes [m, %]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistical data</td>
<td>Standards</td>
<td>Expert knowledge, standards</td>
</tr>
</tbody>
</table>

#### Statistical data

<table>
<thead>
<tr>
<th>Road classes (RC)</th>
<th>Pavement types (PT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Highway Class I (not in Hoa Binh)</td>
<td>Asphalt Concrete (high class) BIN - bê tông nhựa</td>
</tr>
<tr>
<td>Class III</td>
<td>Asphalt Concrete (low class) BIN - bê tông nhựa</td>
</tr>
<tr>
<td>Class IV</td>
<td>Bitumen treatment Pavement DDN - đa dăm (đá dăm nhựa (or Láng nhựa))</td>
</tr>
<tr>
<td>Rural Road District Road</td>
<td>Concrete Pavement BITXR - Bê bêng xỉ mạng</td>
</tr>
<tr>
<td>Commune Road</td>
<td>Aggregate crushed stone CP - Cấp phôi</td>
</tr>
<tr>
<td>Urban Road Arterial</td>
<td>Soil EM</td>
</tr>
<tr>
<td>Collector</td>
<td></td>
</tr>
<tr>
<td>Local Street</td>
<td></td>
</tr>
</tbody>
</table>
### Roads - MCIs

<table>
<thead>
<tr>
<th></th>
<th>Wearing course</th>
<th>Binder course</th>
<th>Base</th>
<th>Subbase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Concrete (high class)</td>
<td>Fine asphalt concrete</td>
<td>Rough asphalt concrete</td>
<td>Aggregate crushed stone type 1</td>
<td>Aggregate crushed stone type 2</td>
</tr>
<tr>
<td>Asphalt Concrete (low class)</td>
<td>Rough asphalt concrete</td>
<td>Aggregate crushed stone type 1</td>
<td>Aggregate crushed stone type 2</td>
<td></td>
</tr>
<tr>
<td>Bitumen Treatment Pavement</td>
<td>Asphalts aggregate crushed stone (small size)</td>
<td>Crushed stones</td>
<td>Natural aggregate stone</td>
<td></td>
</tr>
<tr>
<td>Concrete Pavement</td>
<td>Concrete</td>
<td>Crushed stones reinforced with 6% cement</td>
<td>Aggregate crushed stone type 2</td>
<td></td>
</tr>
<tr>
<td>Aggregate crushed stone</td>
<td>Crushed stones</td>
<td></td>
<td>Natural aggregate stone</td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>Soil</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Assumptions

**New construction & Upgrading**

- Asphalt concrete
- Concrete
- Bitumen treatment pavement
- Aggregates / Crushed stone
- Soil
- Unsealed

![Graphs showing construction and upgrading activities](image)
Future change of roads?

\[
\text{Flow} = \Delta m^2 \text{ road surface} \times \text{MCI}
\]

- Length road network [m] \times Width [m] \times Pavement types
- Expansion ?
- Upgrading ?
- Maintenance ?

Material composition indicators (MCI) of common building types in Vietnam

<table>
<thead>
<tr>
<th>Material Type</th>
<th>[t/m² floor space]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi permanent dwelling</td>
<td>0.0</td>
</tr>
<tr>
<td>Apartment block / Hotel</td>
<td>0.5</td>
</tr>
<tr>
<td>Detached house</td>
<td>1.0</td>
</tr>
<tr>
<td>Tube house</td>
<td>1.5</td>
</tr>
<tr>
<td>Other mineral materials for backfillings</td>
<td>2.0</td>
</tr>
</tbody>
</table>

- Plaster, Screed, Mortar
- Sand for concrete
- Cement for concrete
- Gravel for concrete
- Bricks
Bottom-up calculation model
Residential buildings (RB)

\[
\text{Flow} = \Delta \text{m}^2 \text{ net floor area (NFA)} \times \text{MCI} \\
\text{population [pers]} \times \text{living area per person [m}^2\text{/pers]} \times \text{types of houses [%]}
\]

Past, Today, Future
Buildings - Typology

- Residential buildings
  - Permanent
  - Semi-permanent
  - Temporary
  - Simple

- Industrial buildings

- Urban technical infrastructure buildings

grey: analysed building types

Buildings - MCIs

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

Planning documents

Bills of Qualities

Expert knowledge

MCIs
Future change of buildings?

\[ \text{Flow} = \Delta \text{ m}^2 \text{ net floor area (NFA)} \times \text{MCI} \]

- Official forecasts
- New technologies?
- Housing types?

Past | Today | Future

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
Assumptions

\[
\text{Flow} = \Delta \text{ m}^2 \text{ road surface} \times \text{ MCI} \\
\begin{align*}
\text{Length road network [m]} & \times \text{ Width [m]} \times \text{ Pavement types} \\
\text{Correlation to development of buildings + demolition rate} & \quad \text{No variation}
\end{align*}
\]

\[
\text{Flow} = \Delta \text{ m}^2 \text{ net floor area (NFA)} \times \text{ MCI} \\
\begin{align*}
\text{population [pers]} & \times \text{ living area per person [m}^2\text{/pers]} \times \text{ types of houses [%]} \\
\text{Official forecasts + demolition rate} & \quad \text{No variation}
\end{align*}
\]

Supply ↔ Bottom up demand

[Graph showing supply and demand data with various demand and capacity lines]
Demand differentiated according to materials (only Hoa Binh)
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 Monitoring and Modeling

Environmental Assessment

(2) ĐÁNH GIÁ MTCL (DMC)
(3) ĐÁNH GIÁ TĐMT (DTM)
(3) ĐÁNH GIÁ Chất lượng MT

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)
ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
ENVIRONMENTAL QUALITY ASSESSMENT
1. What is the Environment?

“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.


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.

Figure 1. An environmental impact
### 6. TYPOLOGY OF ENVIRONMENTAL IMPACTS

(Source: World Bank)

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

### Type of Impacts

(Source: World Bank Environmental Safeguard Policies)

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

(Source: World Bank Environmental Safeguard Policies)

<table>
<thead>
<tr>
<th>Impact Duration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary</td>
<td>Impacts are predicted to be of short duration and intermittent/occasional in nature</td>
</tr>
<tr>
<td>Short-term</td>
<td>Impacts that are expected to last only for a limited period (e.g., during facilityakedown) but will cease on completion of the activity, or as a result of mitigation/restitution measures and natural recovery</td>
</tr>
<tr>
<td>Long-term</td>
<td>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</td>
</tr>
<tr>
<td>Permanent</td>
<td>Impacts that occur once or during development of the project and cause a permanent change in the affected receptor or resource (e.g., the loss of a sensitive habitat) that endures substantially beyond the project lifetime</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact Extent</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Impacts are on a local scale</td>
</tr>
<tr>
<td>National</td>
<td>Impacts are on a national scale (affect areas around well beyond the immediate vicinity of the facility and affect an entire region)</td>
</tr>
<tr>
<td>Global</td>
<td>Impacts are on a global scale (e.g., global warming)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact Magnitude</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate of the size of the impact (e.g., the size of the area damaged or impacted, the % of a resource that is lost or affected etc.)</td>
<td></td>
</tr>
</tbody>
</table>
Type of Impacts

Secondary impact

indirect impact

Cumulative 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)
**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.

**Figure 2.** Cumulative impact of TSP from 22 industrial point sources of Hanoi

---

**What are Cumulative Environmental Impacts?**
Time Frames for Project-Specific and Cumulative Impact Analyses

Extend and magnitude of impacts

Impact magnitude of TSP

Impact scope of TSP
Emission sources:
- Point sources (industrial source)
- Line sources (vehicle source)
- Surface sources

Impact scoping

Impact levels

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 these impacts to make them acceptable? (mitigation)
Impact Determination

1. Understanding of the project and its activities

   - Key characteristics of the project in each operation phase
   - Environmental impacts can be created

2. Understanding of environmental values of the project area of influence

   - Characteristics of Natural environment
   - Characteristics of Eco-Social Environment
   - Assessment of values/importance of environmental characteristics

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, qualitatively 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 Thi Phuong Thuy, Pham Thi 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: Regulation of Health Ministry (3733/2002/QDBYT)

An employee is preparing food in the camp at the site

Microclimate conditions
Assessment of Surrounding Environmental Quality:
Compared with the Vietnamese National Technical Regulation on Environment (QCVN)

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

---

**Sectoral Matrices for Identifying Potential ESI**

*(Slice from lecture of Prof. N.C. Thanh)*

<table>
<thead>
<tr>
<th>Sectoral Matrices</th>
<th>Port and Harbours</th>
<th>Airports</th>
<th>Rapid Transit</th>
<th>Highways</th>
<th>Oil/Gas pipelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Quality</td>
<td><img src="image" alt="Matrix Cell" /></td>
<td><img src="image" alt="Matrix Cell" /></td>
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<td><img src="image" alt="Matrix Cell" /></td>
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<tr>
<td>Air quality</td>
<td><img src="image" alt="Matrix Cell" /></td>
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<td><img src="image" alt="Matrix Cell" /></td>
<td><img src="image" alt="Matrix Cell" /></td>
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<tr>
<td>Surface Water Quality</td>
<td><img src="image" alt="Matrix Cell" /></td>
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<td><img src="image" alt="Matrix Cell" /></td>
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<tr>
<td>Erosion</td>
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<td>Fisheries</td>
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<tr>
<td>Land Use</td>
<td><img src="image" alt="Matrix Cell" /></td>
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<td>Land Quality</td>
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<td><img src="image" alt="Matrix Cell" /></td>
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<tr>
<td>Noise</td>
<td><img src="image" alt="Matrix Cell" /></td>
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<td><img src="image" alt="Matrix Cell" /></td>
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<tr>
<td>Aesthetics</td>
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<td><img src="image" alt="Matrix Cell" /></td>
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<tr>
<td>Industries</td>
<td><img src="image" alt="Matrix Cell" /></td>
<td><img src="image" alt="Matrix Cell" /></td>
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<tr>
<td>Television Antennas</td>
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<tr>
<td>Public Health</td>
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<tr>
<td>Socio-Economic</td>
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</tbody>
</table>

**Legend**

- Significant Impact
- Moderate to Significant Impact
- Insignificant Impact
A simple matrix shows the relationship between project activities and environment elements of a quarrying site.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Env. element</th>
<th>Vegetation</th>
<th>Soil</th>
<th>Surface water quality</th>
<th>Air quality</th>
<th>Local infrastructure works</th>
<th>Terrestrial ecosystems</th>
<th>Aquatic ecosystems</th>
<th>Production activities/travel of the people</th>
<th>Public Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling, infrastructure construction</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Removal of vegetation and soil layer cover</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Blasting</td>
<td>***</td>
<td>***</td>
<td>***</td>
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<td>***</td>
<td>***</td>
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</tr>
<tr>
<td>Transportation</td>
<td>***</td>
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<td>***</td>
<td>***</td>
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<td>***</td>
<td>***</td>
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<tr>
<td>Stone processing</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Equipment and machinery maintenance,</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Activities of mine workers</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Environmental reimbursement</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

**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.
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,…

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.
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, inundation…)

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 facilities
• **Point source without the heigh (Excavating, blasting)**

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

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

- **M**: Emission rate (mg/s)
- **U**: Velocity of wind at ground (m/s)
- **C(x,y,0)**: Concentration of pollutants (mg/m³)
- **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 Workshop

Production of Artificial Sand

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

Artificial Sand Production
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]
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]

---

Properties of manufactured and natural sand differ

Table: Manufactured sand characteristics [3].

<table>
<thead>
<tr>
<th>Typical values</th>
<th>Manufactured sand</th>
<th>Natural sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading</td>
<td>packed/dense</td>
<td>open/square</td>
</tr>
<tr>
<td>Filler content (&lt;0.125μm)</td>
<td>10-25%</td>
<td>2-8%</td>
</tr>
<tr>
<td>Surface area</td>
<td>2-300,000 m²/m³</td>
<td>50-70,000 m²/m³</td>
</tr>
<tr>
<td>% cubical particles</td>
<td>30-50%</td>
<td>40-95%</td>
</tr>
</tbody>
</table>
Artificial Sand – Artificial sands vs. natural sands

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Artificial Sand / Manufactured Sand / Crushed Sand</th>
<th>Natural (River) Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Artificial Sand doesn’t contain impurities like silt &amp; silica etc. This sand doesn’t contain any organic matter so; strength of the structure remains same.</td>
<td>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 &amp; weakens strength of structure.</td>
</tr>
<tr>
<td>02</td>
<td>Artificial Sand is made from only one type of stone so; the binding strength between the particles is good.</td>
<td>Natural Sand is made from different type of stones so; binding strength varies.</td>
</tr>
<tr>
<td>03</td>
<td>Artificial Sand has proper gradation of coarse &amp; fine aggregates so; voids are filled completely. This reduces cement consumption.</td>
<td>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 &amp; also increases cement consumption.</td>
</tr>
<tr>
<td>04</td>
<td>Artificial Sand better compressive strength as compared to river sand.</td>
<td>Natural Sand gives low compressive strength as compare to Artificial Sand.</td>
</tr>
<tr>
<td>05</td>
<td>As the voids are filled properly, strength of the concrete is achieved.</td>
<td>As the voids are not filled properly, strength of the concrete is not achieved.</td>
</tr>
<tr>
<td>06</td>
<td>Artificial Sand has constant fineness modulus of aggregate so; no necessity of the change in concrete mix design.</td>
<td>As every truck of Natural Sand has different fineness modulus, every time concrete mix design have to be changed.</td>
</tr>
</tbody>
</table>

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].

<table>
<thead>
<tr>
<th>Destination</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready mix concrete (30% sand)</td>
<td>36 %</td>
</tr>
<tr>
<td>Mortars</td>
<td>18 %</td>
</tr>
<tr>
<td>Pre-cast concrete (25-35% sand)</td>
<td>12 %</td>
</tr>
<tr>
<td>Asphalt (35-45%)</td>
<td>9 %</td>
</tr>
<tr>
<td>Sub-bases</td>
<td>18 %</td>
</tr>
<tr>
<td>Ballast</td>
<td>2 %</td>
</tr>
<tr>
<td>Others</td>
<td>5 %</td>
</tr>
</tbody>
</table>
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

Figure source: [6]

Artificial Sand - Vertical Shaft Impactors

Figure source: [7]

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.

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.
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].

<table>
<thead>
<tr>
<th>Activity</th>
<th>Energy sources</th>
<th>Consumption</th>
<th>CO₂ pr unit</th>
<th>Emission CO₂ (kg CO₂/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blasting</td>
<td>Explosives</td>
<td>0.25 kg/t</td>
<td>2.66 kg/kg aggregate</td>
<td>0.67</td>
</tr>
<tr>
<td>Production</td>
<td>Diesel oil</td>
<td>0.57 liter/t</td>
<td>2.69 kg/litre diesel oil</td>
<td>1.53</td>
</tr>
<tr>
<td>Production</td>
<td>Electrical power</td>
<td>2.30 kWh/t</td>
<td>0 kg/kwh</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>2.20</td>
</tr>
</tbody>
</table>
Artificial Sand – Environmental Impact

Energy and Transportation

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

<table>
<thead>
<tr>
<th>Activity</th>
<th>Energy sources</th>
<th>Consumption</th>
<th>CO₂ pr unit</th>
<th>Emission CO₂ (kg CO₂/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Diesel oil</td>
<td>0.57 litre/t</td>
<td>2.69 kg/litre diesel</td>
<td>1.53</td>
</tr>
<tr>
<td>Production</td>
<td>Electrical power</td>
<td>2.50 kWh/t</td>
<td>0 kg/kwh</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>1.53</td>
</tr>
</tbody>
</table>

Table: Energy consumption – Transportation [2]

<table>
<thead>
<tr>
<th>Type of transport</th>
<th>Energy source</th>
<th>Consumption (litre/km)</th>
<th>Ton pr unit</th>
<th>Consumption (litre/ton x km)</th>
<th>Emission CO₂ (ton/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorry</td>
<td>Diesel oil</td>
<td>0.6</td>
<td>13</td>
<td>0.0462</td>
<td>0.1242</td>
</tr>
<tr>
<td>Vessel, domestic</td>
<td>Diesel oil</td>
<td>5.7</td>
<td>1.000</td>
<td>0.0057</td>
<td>0.0153</td>
</tr>
<tr>
<td>Vessel, Export 1</td>
<td>Heavy oil</td>
<td>26.4</td>
<td>4.000</td>
<td>0.0066</td>
<td>0.0178</td>
</tr>
<tr>
<td>Vessel, export 2</td>
<td>Heavy oil</td>
<td>64.4</td>
<td>27.000</td>
<td>0.0024</td>
<td>0.0064</td>
</tr>
</tbody>
</table>

CO₂ 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


References


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

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
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

State of the technique:

- Wellhole blasting
- Single-row or bench blasting

Figure source: https://www.blick.ch/news/schweiz/zentralschweiz/sprengung-am-gotthard-verkehrsschaos-mit-ansage-wege-ins-tessin-gesperrt-id1801112.html
Structures of investigated open pit mines – Hoa Binh drilling and blasting

Further examples:

Bench blasting combined with wellhole blasting
Precondition: regulated mine development as well as berm mining, as example

Drilling: Equipment technology

- 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

- 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

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

Primary influence:

- Location of the cut
- Ignition angle
- Ignition sequence

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

http://www.constructionphotography.com/Details.aspx?ID=17872&TypeID=1
Structures of investigated open pit mines – Hoa Binh drilling and blasting

Secondary crushing:
- blasting
- manually
- mechanically

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
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

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

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

- 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


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: Bundesverw. Baustoffe - Steine und Erden: Jahresberichte / Bundesverband Baustoffe - Steine + Erden e.V.
/5/ Aßbrock, O.: Beitrag zur Beurteilung des Sprengerfolges von Gewinnungssprengungen im Festgesteinstagebau mit Hilfe der digitalen Bildverarbeitung und -analyse
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

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

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
Assessment Status – Interim results

- 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

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
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 conveying
Main products: crushed rock, grit, aggregates
Mining direction: parallel to the cut berms (90 degree offset to the cutting direction, downwards)

Explosive consumption: 0,5 kg/m³
### Structures of investigated open pit mines – Hoa Binh

#### Main parameter

<table>
<thead>
<tr>
<th>No.</th>
<th>Material</th>
<th>Ser. No.</th>
<th>Internally annual extraction</th>
<th>Explosive consumption kg/m³</th>
<th>Main parameter</th>
<th>Water consumption</th>
<th>Mining regime</th>
<th>Safety</th>
<th>drilling and blasting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>basalt</td>
<td>187</td>
<td>20</td>
<td>0.4 kg/m³</td>
<td>272 Tl</td>
<td>2,7 m</td>
<td>no information</td>
<td>regularly yes, about berms</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>basalt</td>
<td>185</td>
<td>20</td>
<td>0.28 kg/m³</td>
<td>240 Tl</td>
<td>1,5 m</td>
<td>no information</td>
<td>no information</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>limestone</td>
<td>86</td>
<td>50</td>
<td>0.37 kg/t</td>
<td>no information</td>
<td>no information</td>
<td>720 l/year</td>
<td>no information</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>limestone</td>
<td>1.114,2</td>
<td>26</td>
<td>0.167 kg/m³</td>
<td>30 Tl</td>
<td>10 T</td>
<td>regular yes, via berms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>limestone</td>
<td>187</td>
<td>30</td>
<td>0.63 kg/m³</td>
<td>180 Tl</td>
<td>2,2 m (max.)</td>
<td>uncontrollably no safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>limestone</td>
<td>93</td>
<td>26</td>
<td>0.24 kg/m³</td>
<td>48 Tl</td>
<td>1,44 m</td>
<td>uncontrollably no safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>limestone</td>
<td>44,6</td>
<td>0,18 kg/m³</td>
<td>no information</td>
<td>55 Tl</td>
<td>2,7 m</td>
<td>uncontrollably no safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>limestone</td>
<td>44</td>
<td>0,16 kg/m³</td>
<td>48 Tl</td>
<td>1,9 m</td>
<td>150 m³/Monat</td>
<td>partly controlled, about berms yes, via berms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>limestone</td>
<td>100</td>
<td>0,17 kg/m³</td>
<td>100 Tl</td>
<td>not comparable</td>
<td>9 m³/day</td>
<td>partly controlled, about berms yes, via berms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>limestone</td>
<td>40</td>
<td>0,075 kg/m³</td>
<td>high proportion of blocks (20%)</td>
<td>120 Tl</td>
<td>480 T 20 m³/month mining regime is planned, but not implemented no safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>limestone</td>
<td>105,8</td>
<td>0,1…0,2 kg/m³</td>
<td>66 Tl</td>
<td>no information</td>
<td>425,04 T</td>
<td>partly controlled, about berms yes, via berms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>limestone</td>
<td>47</td>
<td>0,31 kg/m³</td>
<td>60 Tl</td>
<td>2,7 m</td>
<td>4…5 m³/day</td>
<td>regularly yes, via berms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>limestone</td>
<td>370</td>
<td>0,36 kg/m³</td>
<td>520 Tl</td>
<td>2,3 m</td>
<td>24 m³/day</td>
<td>according to operating plan yes, stope height 15…18 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) Comparison Kalkwerk Ostrau

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### Structures of investigated open pit mines – Hoa Binh

**International comparison**

Spatial distribution of quarries visited by module 2 in Lang Son (Nov/2016)

Legend:
- Solid orange: Quarry
- Transparent orange: Internal boundaries of Lang Son communities
Structures of investigated open pit mines
Mining technology

- Field visit of selected Open pit mines in the period 14.11. – 18.11.2016

Main focus:
- Exploratory and pre-processing works
- Mining
- Extraction
- Milling, Processing
- Marketing

Field visit 14.11. – 18.11.2016
- Exploratory and pre-processing works
- Construction of access roads and ramps
- Build up of slopes and berms (LHD technics)
- (German: Aus- und Vorrichtung)
Structures of investigated open pit mines
Field visit 14.11. – 18.11.2016

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

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

- Extraction
- Drilling
- Blasting
- Loading
- Hauling
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 continuous mineral extraction.

- This kind of "climbing and blasting" exploitation is extremely dangerous for the involved workers, especially if they have to transport the drilling equipment and explosives uphill without any protection equipment for mountaineering.
Identified Problems - Interim Results

[Images of identified problems with annotations and dates: 11.11.2016 and 12.11.2016]
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 continuous 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).

Interim Results

- Clay 1
- Limestone 23
- Basalt 3
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.
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.

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

Mining approval procedures in Saxony [3]
Structures of investigated open pit mines – Hoa Binh
International comparison

Gross production of stone and earth

<table>
<thead>
<tr>
<th>Type of resource</th>
<th>Gross Production in 2014 (million t)</th>
<th>Quantity of extracting companies in 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid rock</td>
<td>19.76</td>
<td>70</td>
</tr>
<tr>
<td>Gravel and gravelly sand</td>
<td>14.11</td>
<td>101</td>
</tr>
<tr>
<td>Kaolin</td>
<td>1.60</td>
<td>11</td>
</tr>
<tr>
<td>Clay, brick earth</td>
<td>1.03</td>
<td>12</td>
</tr>
<tr>
<td>Lime and dolomite</td>
<td>0.54</td>
<td>3</td>
</tr>
<tr>
<td>Silica and foundry sand</td>
<td>0.044</td>
<td>1</td>
</tr>
<tr>
<td>Special clay</td>
<td>0.32</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37.40</strong></td>
<td><strong>206</strong></td>
</tr>
</tbody>
</table>

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

Discrepancy between approved design and reality

- Access road with ramps, berms and lower loading area

- The mine is designed for a regular „group-extraction method“
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 sufficiently.

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

Spatial distribution of mines according to the type of minerals by DONRE 2017

Legend
- Type of minerals (6 mining areas)
  - Ironstones (N)
  - Sandstone (S)
  - Exploration rock (E)
  - Sand from the river (G)
  - Slag (T)
- Administrative boundaries of Hoa Binh province
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.

• 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]

![Diagram](image)
Sources


[5] Own images K.-D. Oswald
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.
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A Contribution to Sustainable Development in Vietnam

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