Data and Analysis Methodologies for Aggregates Planning: In support of best practices in Sustainable Aggregates Planning

May 2014

Technical
University
of Crete

Provincia autonoma di Trento

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Data and Analysis Methodologies for Aggregates Planning: In support of best practices in Sustainable Aggregates Planning

Based on:

the reports prepared within Work Package 4 of the SNAP-SEE Project
“Sustainable Aggregates Planning in South East Europe” (SEE/D/0167/2.4/X)

Website: <http://www.snapsee.eu>

Deliverable of Activity 4.3: Handbook on Data and Analysis Methodologies for Aggregates Planning: A joint manual for planning authorities in the SEE region

Publication Information

Editing & Layout:	Foteini Stathogianni
Cover Design:	Stelios Mavrigiannakis
Printing:	Geological Survey of Slovenia
Year of Edition	2014

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Handbook Authors

Agioutantis, Zach, Dr. , Technical University of Crete (TUC), Greece Komnitsas, Kostas, Dr. , Technical University of Crete (TUC), Greece Steiakakis, Manolis, Dr. , Technical University of Crete (TUC), Greece Mavrigiannakis, Stelios , Technical University of Crete (TUC), Greece Stathogianni, Foteini , Technical University of Crete (TUC), Greece
Chalkiopoulou, Fotini , Institute of Geology & Mineral Exploration (IGME), Greece Hatzilazaridou, Kiki , Institute of Geology & Mineral Exploration (IGME), Greece
Provincia autonoma di Trento	Moltrer, Alessandro , Autonomous province of Trento- Environmental Protection Provincial Agency, Italy Valbusa, Michele , Autonomous province of Trento- Environmental Protection Provincial Agency, Italy
Bobba, Silvia , Politecnico di Torino, Italy Blengini, Gian Andrea, Dr. , Politecnico di Torino, Italy

Reviewers

Name	Affiliation
Shields, Deborah J., Dr.	Colorado State University, United States of America
O'Brien, Jim	Former President of the European Aggregates Association, Ireland
Simic, Vladimir, Dr.	University of Belgrade, Faculty of Mining and Geology, Serbia

Acknowledgments

The SNAP-SEE project partners would like to thank the European Commission for funding this project which led to a fruitful cooperation between partners sharing similar issues and a common vision, and allowed the development of this handbook.

The authors would like to acknowledge the contribution of all partners in the development of the material presented in this handbook.

Digital Object Identifier (DOI)

10.5474/snapsee-WP4-EN

Citation

This handbook should be cited in the bibliography with using doi number as follows: Agioutantis Z. et al. (2014), Data and Analysis Methodologies for Aggregates Planning: In support of best practices in Sustainable Aggregates Planning, SNAP-SEE Project, <http://www.snapsee.eu>. doi: 10.5474/snapsee-WP4-EN

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Foreword

The countries in South East Europe (SEE) are rich in construction aggregates, i.e. crushed stone, gravel, sand and other granular inert materials used in the construction industry; however, these resources are not evenly distributed across the region resulting in abundance in some areas and shortage in others. Furthermore, access to these resources is becoming increasingly difficult due to other infrastructural developments and environmental pressures. As aggregates are heavy and bulky, transport is expensive, therefore access to resources local to the market is crucial. The SEE region will probably require 50% higher output of aggregates by 2020 in order to build its growing infrastructural needs.

Hence, there is a need to shift to sustainable aggregate resource management (SARM) and provide a sustainable supply mix (SSM) of aggregates to the region to enhance resource efficiency and support sustainable development. SARM is efficient, low socio-environmental impact quarrying and waste management, coupled with broad stakeholder engagement. A SSM is composed of aggregates from multiple sources, including recycled construction and demolition wastes and industrial by-products (slag), as well as both domestically produced and imported primary materials, that together maximize net benefits of aggregate supply across generations.

Implementing SARM and SSM requires a supporting policy and planning framework. Due to regional differences and historical development, approaches to aggregates policy, planning and management differ at various political scales within and across SEE and in few cases are fully comprehensive. Challenges include policies and plans affecting aggregates management and provision that are distributed among many different legal documents, making coordination and a comprehensive understanding difficult. There is also a lack of coordination on planning for supply from primary and secondary aggregates. SEE lacks sufficient data to support aggregates planning, inadequate capacity and competence for addressing either primary and/or secondary aggregates planning, and insufficient stakeholder participation in the development of aggregates management plans. The SNAP-SEE Project has addressed these deficits in order to foster the growth of a vibrant, responsible and sustainable aggregates industry in the SEE region.

The specific purpose of the Sustainable Aggregates Planning in South East Europe (SNAP-SEE) project was to create and disseminate a Toolbox for Aggregates Planning to help governments and stakeholder in SEE collaborate to enhance their aggregates planning and management processes. SNAP-SEE built on the results of the Sustainable Aggregates Resource Management (SARMa) project, a preceding SEE Transna-

tional Cooperation-funded project (<http://www.sarma.eu>). SNAP-SEE was funded by the EU South East Europe (SEE) Transnational Cooperation Programme (SNAP-SEE, SEE/D/0167/2.4/X) and had 27 partners from 12 SEE countries and Turkey. The University of Leoben, Austria, was the Lead Partner. SNAP-SEE was a 2 year project that ended in November of 2014.

The SNAP-SEE Toolbox for Aggregates Planning comprises 4 products that are inter-related and mutually supporting.

1. A Vision of Best Practices for Aggregates Planning in South East Europe

The 'Best Practices' document presents a Vision for a transition to integrated, comprehensive sustainable planning in SEE. It includes discussions of the issues that need to be addressed, interim steps that can be taken toward more sustainable planning, and a review of the components a sustainable plan should contain.

2. How to Build a Sustainable Aggregates Plan

The 'How to' document represents a roadmap for planning, including discussions of the planning process itself and its various steps. Examples of well written planning modules are provided that embody the principles, approaches and actions necessary to achieve the goals of the Vision laid out in the Best Practices report.

3. Consulting Stakeholders when Applying Best Practices in Sustainable Aggregates Planning

The 'Consultation' document provides a step-by-step guide for how to plan and conduct stakeholder consultations so as to ensure that industry, government, non-governmental organizations and civil society can provide input to and participate in the planning process. Capacity building materials are also provided.

4. Data and Analysis in Support of Best Practices in Sustainable Aggregates Planning

This document discusses the various types of data that provide essential background information for the planning process. Data definitions, significance, availability, structure and needs are addressed. Methods for validating and analyzing data are presented, including approaches to demand forecasting.

Project Coordinator
Gunter Tiess

Montanuniversität Leoben
(University of Leoben)

1. Introductory Information

Ensuring sustainable supply of aggregates is an important challenge due to the limited availability of natural resources when aiming at sustainable development. Due to the regional differences and historical development, there are diverse approaches to aggregates policies, planning and resource management in South East Europe, which is hindering resource efficiency and economic development in the region. Successful planning for the management of aggregate resources and the supply of primary and secondary aggregates requires a wide variety of supporting information to ensure that everything required is being taken into consideration. Otherwise, the objectives of the plan may be difficult or impossible to achieve, or plans created in the absence of adequate information may be unrealistic or even counterproductive, particularly with respect to resource efficiency. It is also the case that in most South East European (SEE) countries, secondary aggregates are not considered in planning for aggregates supply, e.g., volumes of available materials extracted from civil works are not reported and therefore are not considered. In order to support effective and sustainable national / regional plans for primary and secondary aggregates the full range of data needed have to be identified.

1.1 The Need for Aggregate Planning

Aggregates (crushed stone, sand and gravel) are essential for the residential, social and commercial infrastructure of modern European society. Europe currently consumes about 3 billion tonnes of aggregates per year produced by about 26000 quarries. Consumption in Europe ranges from 2 to 16 tonnes per capita (UEPG, 2013). Table 1 shows the estimated consumption for SEE countries which averages 3.5

Table 1.1: Estimated SEE Region Tonnages (UEPG, 2013)

	Consumption (million tonnes)	population (million people)	Tonnes/capita
Albania	10	3.2	3.1
Bosnia – Her- zegovina	12	3.8	3.2
Bulgaria	29	7.6	3.8
Croatia	13	4.4	3.0
Greece	25	11.3	2.2
Hungary	36	10.0	3.6
FYROM	6	2.0	3.0
Montenegro	2	0.6	3.3
Romania	96	22.0	4.4
Serbia	17	7.3	2.3
Slovakia	23	5.4	4.3
Slovenia	9	2.0	4.5
Totals/Average	278	79.6	3.5

tonnes per capita.

About 90% of these aggregates come from naturally-occurring deposits, while the remaining 10% comes from recycled materials, marine and manufactured aggregates. The later production will continue to grow, however in the longer-term some 85% of demand will still need to come from natural aggregates. As aggregates are heavy and bulky, their sources should be close to the consumption centers due to obvious economic and environmental reasons (Leoben, 2010).

Figure 1.1 presents the relationship of the Gross Domestic Product (GDP) per capita for all European countries to the corresponding aggregate consumption per capita. Clearly, the consumption of aggregates increases with GDP and therefore, consumption in the SEE countries is expected to increase in the coming years as the GDP increases.

Figure 1.1: GDP per capita versus Tonnes per capita for all European countries (UEPG 2013)

1.2 Scope and Structure of the Handbook

This handbook focuses on the data and data methodologies needed to achieve sustainable planning of aggregates, providing a data framework to support effective resource management for both primary and secondary aggregates. Fig. 1.2 presents a simplified diagram of the supply and demand chain related to sustainable aggregates planning. Planning for aggregates supply is a governmental activity, and the objective is to determine the policies, legal framework, actions, and information that will be needed to ensure the availability of adequate quantities of primary and secondary aggregates to the national and regional economies in the short, medium and long term.

Some general considerations are presented in Chapter 2 and the concept of an information matrix is presented in Chapter 3. Chapter 4 focuses on the data sets needed for each contributing area while Chapter 5 presents the data analysis methodologies for estimating aggregate demand.

1.3 Definition of Selected Terms

Most of the definitions referred to hereafter, if not otherwise stated, are based on the glossary developed within the SARMa project (SARMa, 2011).

Aggregate

Granular or particulate material, either naturally occurring (sand and gravel) or produced by crushing (crushed rock) which, when brought together in a bound (with cement, lime or bitumen) or unbound condition, is used in construction to form part

Figure 1.2: Planning should consider the supply and demand chain and other constraints

or whole of a building or civil engineering structure. Also referred to as “construction aggregates” and used mainly as concrete, mortar, roadstone, asphalt or drainage courses, or for use as construction fill or railway ballast.

Aggregates Planning

Aggregates planning policies are declared governmental objectives in the field of aggregates; planning is the creation of formal procedures to be followed to achieve objectives; and planning management is the administration of procedures.

Aggregate consumption

Apparent consumption is calculated from data on known sales within each region (or sub-region), plus known imports from other regions (or sub-regions) and, where appropriate, known imports from other countries. It is less than total consumption due to unallocated sales of unknown destination which, therefore, cannot be attributed to any consuming region (or sub-region). Further, some caution should be used in interpreting the consumption figures as they are calculated from the principal destination of aggregate flows (Welsh Assembly Government, 2011).

Aggregate mineral survey

The Aggregate Mineral Survey is a voluntary survey of aggregate production and reserves undertaken every several years (e.g., four or five). The results of the survey are vital for monitoring and developing planning policy for the supply of aggregates (BGS, 2014a).

Aggregate sales

The tonnage of mineral leaving a quarry as measured at a weighbridge (Welsh Assembly Government, 2011).

Authority

The concept of an “authority” has been given a large scope in the case law of the European Court of Justice (ECJ). It can be defined as a body, whatever its legal form and regardless of the extent (national, regional or local) of its powers, which have been made responsible, pursuant to a measure adopted by the State, for providing a public service under the control of the State, and it has for that purpose special powers beyond those which result from the normal rules applicable in relations between individuals (SEA, 2001).

Borrow pits

A site for the extraction of aggregates over a limited period, for exclusive use in a specific construction project, which will usually be close to or contiguous with the site (Welsh Assembly Government, 2011).

Demand

Demand is the want or desire to possess a good or service with the necessary goods, services, or financial instruments necessary to make a legal transaction for those goods or services

Demand forecast

Estimate of expected demand over a specified future period. Also called forecast demand.

Development plan

Development plans identify the demographic, economic, environmental and social needs of the area and set out a long-term strategy to address them. For minerals, the key strategic aim is to provide policies and land allocations that do not prevent mineral working yet accommodate community and environmental interests. Strategic Environmental Assessment (SEA) of development plans will ensure that the environmental consequences of the development strategy are rigorously examined (SPP, 2006).

Extractive waste (or mining waste)

Waste resulting from the prospecting, extraction, treatment/processing and storage of mineral resources and the working of quarries.

Landbank

A stock of planning permissions for reserves that ensure continuity of production for a set number of years (BGS, 2014a).

Land use planning

An activity, generally conducted by a local government that provides public and private land use recommendations consistent with community policies and public preferences. Generally is used to guide decisions on zoning.

Life Cycle Assessment (LCA)

Life Cycle Assessment is an investigation into the environmental impacts of a product, process or service, for its entire lifespan. It then places values upon these impacts to give an overall evaluation of its environmental, as opposed to its monetary, cost.

Manufactured aggregates

Aggregates produced from industrial activities as processing or re-processing of waste, by-products and residues.

Material Flow Analysis (MFA)

Material flow analysis refers to the monitoring and analysis of physical flows of materials into, through and out of a given system (usually the economy) through the process chains, through extraction, production, use, recycling and final disposal. MFA is generally based on methodically organized accounts in physical units (Material flow accounts). The term MFA is used in a generic way to designate a family of tools encompassing different types of accounts, indicators and evaluation methods at different levels of ambition, detail and completeness.

Mineral Planning Authority

The planning authority responsible for planning control of minerals development. The mineral planning authorities are the statutory bodies (county councils, metropolitan borough councils, national park authorities, etc.) which control mineral workings in their areas. They are given guidelines by the government in the form of national and regional strategies and guides (BGS, 2014a).

Mineral resources

Are defined as natural concentrations of minerals or, in the case of aggregates, bodies of rock that are, or may become, of potential economic interest due to their inherent properties (for example the high crushing strength of a rock or its suitability for use as an aggregate). The mineral will also be present in sufficient quantity to make it of intrinsic economic interest (BGS, 2014b).

Mineral reserves

That part of a mineral resource, which has been fully evaluated and is deemed commercially viable to work and has a valid planning permission for extraction. Reserves will need to meet not only the requirements of geological certainty and economic viability, but also accessibility based on legal permission to extract the mineral. Therefore, in the context of land-use planning, the term mineral reserve should be further restricted to those minerals with legal access and for which a valid planning permission for extraction also exists (i.e., permitted reserves). Aggregate reserves are of crucial importance to the planning process in ensuring that an adequate and steady supply of aggregates is available to meet society's future needs (BGS, 2014c).

Natural aggregates

Aggregates from mineral resources which has been subjected to nothing more than mechanical processing.

Permitted reserves

Mineral deposits with the benefit of planning permission for extraction (BGS, 2014a).

Planning conditions

Requirements attached to a planning permission to limit or direct the manner in which a development is carried out (BGS, 2014a).

Planning permission

Formal approval sought from a council, often granted with conditions, allowing a proposed development to proceed. Permission may be sought in principle through outline plans, or be sought in detail through full plans (BGS, 2014a).

Primary aggregates

Aggregates produced from naturally-occurring mineral deposits, extracted specifically for use as aggregate (BGS, 2014a).

Recycled aggregates

Aggregates obtained from recycling of construction and demolition waste. The “Percentage Recycled” is calculated as the percentage of available Construction and Demolition materials that are suitable for recycling.

1. Aggregates derived from both construction waste, for example damaged bricks, and demolition waste, such as broken concrete, brickwork and masonry.
2. Aggregates resulting from the processing of inorganic material previously used in construction.

Reserves

See Mineral Reserves

Resources

A concentration of a mineral commodity of which the location, grade, quality and quantity are known or estimated from specific geologic evidence.

Resource efficiency

A practice in which the primary consideration of material use begins with the concept of "Reduce - Reuse - Recycle - Repair" stated in descending order of priority.

Social License to Operate

A social license to operate (SLO) refers to the perceptions of local stakeholders that a project, a company, or an industry that operates in a given area or region is socially acceptable. Whereas a license in the legal meaning of the term refers to a document issued by an authorized legal entity, e.g., a city, a state/province, or a national government, whereby the latter grants an authorization to build, operate, or change activities with clearly established spatial, temporal, financial, or social parameters, the social license to operate refers to a more implicit form of agreement between a company and local stakeholders (Springer 2014).

Sustainable Aggregate Resource Management (SARM)

SARM is efficient and low socio-environmental impact quarrying and waste management throughout the quarry life-cycle. SARM is directly related to quarrying. In this sense potential secondary aggregate resources are not included.

Sustainable Supply Mix (SSM)

SSM means that the demand for aggregates should be fulfilled with a mix of primary and secondary aggregates that together maximize net benefits of aggregates supply across generations.

Secondary aggregates

Aggregates which originate as a waste of [other quarrying and] mining operations, or from industrial processes (e.g., colliery waste or mine stone, blast furnace slag, power station ash, china clay sand, slate waste, demolition/construction waste including road planning), but excluding chalk and clay/shale worked primarily for aggregate purposes.

Spatial planning

Spatial planning goes beyond traditional land-use planning to bring together and integrate policies for the development and use of land with other policies and programmes which influence the nature of places and how they function. That will include policies which can impact on land use, for example by influencing the demands on, or needs for, development, but which are not capable of being delivered solely or mainly through the granting or refusal of planning permission and which may be implemented by other means (BGS, 2014a).

Strategic Environmental Assessment

An environmental assessment of certain plans and programmes, including those in the field of planning and land use, which complies with the EU Directive 2001/42/EC. The environmental assessment involves the: preparation of an environmental report; carrying out of consultations; taking into account of the environmental report and the results of the consultations in decision making; provision of information when the plan or programme is adopted; and showing that the results of the environment assessment have been taken into account (BGS, 2014a).

Supply

The amount of a product (good or service) available for purchase at any specified price. Supply is determined by cost of inputs. Price is determined by the intersection of supply and demand.

Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

1.4 Aggregate Categories

1.4.1 Primary aggregates

Primary aggregates are produced after mechanical processing of mineral raw materials extracted for the specific use from quarries or pits. They can be either sand and gravel or hard rock. In some cases marine aggregates are also included (Fig 1.3).

1.4.2 Secondary aggregates

The term “secondary aggregates” is used here to describe aggregates which originate as a waste of [other quarrying and] mining operations, or from industrial processes (e.g., colliery waste or mine stone, blast furnace slag, power station ash, china clay sand, slate waste, demolition and construction waste including road construction), but excluding chalk and clay/shale worked primarily for aggregate purposes (Fig 1.3).

Primary aggregates constitute the products of exploitation of non-renewable natural resources, thus rational use is required in order to extend the life-time of reserves. One of the ways to achieve this goal is to supply the market with alternative materials. In this context, it is government policy to reduce the contribution of aggregate supply from land sources by encouraging the wider use of alternatives, notably recycled and secondary aggregates. Where appropriate, planning authorities should identify the volume of secondary resources that could be used as aggregates. In particular, the use of recycled aggregates (R2) (Fig. 1.3) has been increasing as a number of countries / regions have been adjusting their objectives and policies in aggregate planning. Recycled aggregates can help meet future aggregate demand and reduce the need for primary aggregates through re-use of the material that would otherwise be dumped.

Figure 1.3: Classification of potential aggregate resources

2. Significance of Data and Analysis Methods for Planning

The availability of reliable historic data sets both accurate and without any time gaps is an important input to any successful planning exercise at any level. Planning authorities at all levels should have access to the permitted reserves, the annual capacity to produce and the actual annual production of primary and secondary aggregates (where available in the aggregate supply mix) in order to be in a position to successfully manage the current needs of the construction industry and to plan for future large scale civil infrastructure works like road and bridge construction.

2.1 General Considerations

Planning for aggregates is accomplished at a national or a regional / local level, depending on the degree of decentralization of each country. It is of great importance to delimit the area of interest for aggregates planning in each separate case. If the planning process is not an established one, which is the case with most SEE countries, a number of preparatory steps are needed prior starting to plan (Fig 2.1). A planning process should follow the principles of Sustainable Aggregate Resources Management (SARM) and Sustainable Supply Mix (SSM). SARM provides a framework for developing resource management policies in order to maximize benefits and minimize costs of aggregates supply and should be viewed in the broader context of minerals policy specific to the group of aggregates.

Figure 2.1: Necessary preparatory steps for sustainable aggregate planning

It should be noted that a national aggregates policy framework, if it exists, should provide a minerals statement, objectives, strategies, and an action plan. A SARM policy influences the development of aggregates markets based on several tools and instruments. For instance, providing concepts related to energy efficient aggregates transport, i.e., reducing the transport distance by different means (e.g. CO₂ taxes). Sustainable Supply Mix (SSM) uses multiple sources, including recycled waste and industrial by-products (slag) that together maximize the net benefits of aggregates supply across generations. The SARM policy framework determines the framework for SSM planning (for instance, aggregates planning policies based on land use planning) as well as the SSM regulatory framework.

SSM planning is related to the planning / development process by the respective stakeholders / authorities using these multiple sources in order to secure a sustainable supply of aggregates. In general, however, this type of planning is not fully developed in many SEE countries / regions. A crucial aspect of a SARM and SSM (i.e. sus-

tainable planning) policy is data management. Without proper data and robust data and data analysis procedures a realistic sustainable planning policy framework cannot be applied.

In most SEE countries the issues related to primary aggregates are (at the moment) managed separately, from those related to secondary resources; this makes planning for SSM very challenging. Application of SSM policies means that the demand for aggregates should be fulfilled with a mix of primary and secondary aggregates that together maximize net benefits of aggregates supply across generations. All of the concerned stakeholders, e.g., those responsible for land use planning or for regulating the planning process of recycled aggregates and the sustainable use of natural resources, as well as industry, local communities, NGOs and civil society, should act in close cooperation (Fig. 2.2). The SSM planning framework provides “basic operation rules” for the primary and secondary aggregates industry.

Figure 2.2: Aggregates planning depends on other planning efforts

2.2 Significance of Data for Sustainable Planning

In simple terms, when planning for aggregates two questions need to be clearly answered: (a) How much aggregate material is needed to cover the needs of a particular consumption area for a specific future time-period and (b) how much is available from primary and secondary sources in this area?

It is self-evident that a great amount of diverse data, such as maps, figures, statistics, legislation, is needed in order to be able to answer these questions. Obtaining the required data is only part of the effort that planning authorities should make in order to compile even a simple plan for aggregates. The other part includes all the necessary data management activities, i.e., validation of data, analysis and compilation of raw data into indices and new data etc. Moreover, a sustainable planning of aggre-

gates requires involvement of methodologies such as life cycle analysis in order to assess which is the preferable solution amongst alternatives. The necessity for an integral knowledge of the related provisions, both the prevailing ones as well as those under preparation, should be added which is a prerequisite for any realistic planning policy and/or activity.

Information necessary in the data collection scheme for primary aggregates should include typical characteristics of primary aggregates such as origin, composition, mechanical properties, etc. More important, however, are the so-called “permitted reserves”, i.e., reserves for which all the stages towards obtaining an exploitation permit have been completed, and thus, can immediately contribute to the installed capacity for aggregates. Non-permitted resources take considerable time to mature to permitted reserves and, therefore, can only be considered as potentially available to be included in the supply stream. In addition, the pathways to drive secondary or recycled aggregates back to the supply stream are different. The majority of the countries in the SEE have not exploited this potential yet.

Apart from the technical characteristics and the spatial availability of aggregates successful planning should consider other indices such as the rate of population growth, the economic potential in the region, etc.

Such data will be needed to run demand forecast models, life cycle assessment models, material flow analysis scenarios and also consider social data paradigms. Analysis results should be used in combination with available resources and their spatial distribution as well as land use planning in order to allow authorities to make informed decisions regarding the sustainable planning for aggregates. This can lead to an effective and efficient use of natural resources and the mitigation of the environmental impacts to the region and neighboring regions. Figure 2.3 shows a typical example of material flow within and between neighboring regions.

Figure 2.3: A typical example of material flow between neighbouring regions

2.3 Data Availability in the SEE Countries / Regions

In order to identify the data available for planning for primary and secondary aggregates (e.g., extractive waste, Construction and Demolition Waste (C&DW), industrial waste, material excavated from civil works, etc.) for each country / region represented in this SEE project, a questionnaire was developed. The partners of the SNAP-SEE project provided information on data availability, sources and use to support sustainable aggregates planning in their respective countries/regions. Also, each partner was asked to determine the degree to which such data are available in 13 countries / regions, under whose jurisdiction their collection and reporting falls, and whether they are being used currently in planning. More specifically, the issues raised in the questionnaire were related to:

- ✓ the data that are considered important for aggregates planning;
- ✓ the data that are missing or not currently considered in planning;
- ✓ the degree of data availability and accuracy and the problems encountered that influence data collection and accuracy;
- ✓ the responsible agency for data collection, storage, reporting and updating;
- ✓ the format in which the data are available;
- ✓ the level of detail of data collection and their sources;
- ✓ the data analysis methods which are utilized to convert raw data into useful supporting information for aggregates planning.

As was concluded after processing the completed questionnaires, most SEE countries / regions keep archives and maps on the distribution of primary aggregate resources and permitted reserves, on the location of extraction sites, on the quality per field of application (e.g., chemical and mineralogical analysis, particle size analysis, physical and mechanical properties according to technical standards) and on production. Estimated demand forecasts data and data on aggregate consumption are only available in few countries. Most of the data are stored in digital databases and maps in the majority of the surveyed SEE countries / regions (Fig. 2.4).

The basic geological information regarding distribution of primary aggregate resources (e.g., geological maps of 1:50.000 to 1:100.000 scales, location maps of extractive and abandoned sites, lithology, a broad assessment of the quality of the resources, etc.) are usually provided by the country's national geological survey.

Data on permitted reserves, production and production capacity of the quarry operations, quality (according to specifications regarding fields of application), sales and sale value of aggregate products, are provided by the quarry operators (usually on a yearly basis) and collected/evaluated by the competent ministries (and/or regional

authorities) in charge to authorize and control the activities of the mining/quarrying sector in each SEE country / region. Statistical reports regarding historic production, consumption, needs and trends in future supply and demand, are usually carried out by the competent ministry(ies) in each country (e.g., Ministry of Economy, Ministry of Environment, Ministry of Mining and Spatial Planning, Ministry of Transport) and offices for national statistics service.

Figure 2.4: Availability of data per data category in 13 South East European (SEE) countries or regions (Hatzilazaridou, 2014).

Data regarding produced volumes of secondary resources and the percentage of secondary materials recycled, when available, are mostly estimated. In addition, data on the percentage of the recycled portions being used as aggregates are practically absent, with the exception of one or two countries / regions (Table 2.1).

Here it should be noted that, in most SEE countries, secondary resources are not considered in the planning for aggregates supply. Therefore, databases on secondary resources are either missing or contain limited and often not reliable information. It should be noted that the recycling percentage of just the C&DW stream, is still very low in most SEE countries / regions. In the SEE region, the data are available either on a regional or on a national level, depending mainly on i) which level the aggregates' planning is performed, ii) the type of data collected and iii) the level of the planning authority.

Summarizing the main results of the specific survey, it was concluded that i) the aggregate resources inventories are not equally developed in all SEE countries / regions, ii) the data contained in these inventories may not be regularly updated or kept in digital form, iii) the data may be derived from different sources, and, there-

fore, they are not always compatible and easily traceable, iv) the information registered in the inventories may not be regularly crosschecked thus raising reliability issues and v) in most SEE countries / regions, the existing inventories do not include data on secondary resources.

Table 2.1: Availability of data on secondary aggregate resources in the SEE countries (Hatzilazaridou, 2014)

Country / Region	Data on production volumes per type of recycled waste (tonnes)					
	R1 (*)	R2 (*)	R3 (*)	R4 (*)	Data on % of secondary materials recycled	Data on % of recycled used as aggregates
Albania	Estimated	NO	NO	Estimated	NO	NO
Austria	Estimated	YES	NO	YES	YES (R2) YES (R4)	NO
Croatia	Estimated	Estimated	Estimated	Estimated	NO	NO
Emilia Romagna	YES	YES	NO	YES	YES	NO
Greece	NO	Estimated	NO	Estimated	NO	NO
Herzegovinian Canton	NO	NO	NO	NO	NO	NO
Hungary	Estimated	Estimated	NO	Estimated	YES	NO
Montenegro	Estimated	NO	NO	Estimated	NO	NO
Romania	Estimated	NO	NO	Estimated	NO	NO
Serbia	Estimated	NO	NO	Estimated	YES (R1) NO (R4)	YES (R1) NO (R4)
Slovakia	Estimated	Estimated	NO	Estimated	NO(R1) YES (R2) YES(R4)	NO
Slovenia	Estimated	YES	NO	Estimated	YES(R1) YES(R2) NO (R4)	NO
Trento	Estimated	YES	Estimated	YES	NO (R1) YES (R2) NO (R3) YES (R4)	YES (R2)

(*) See Fig 1.2 for explanation

3. Organizing the Information

Aggregate planning involves analysis of distinct processes within the life cycle of materials. These processes are termed “focus areas” since planning should address them individually and collectively at the same time. Such processes are interconnected with material flows, which may vary per planning level. The information matrix represents a hierarchical structure system which helps organize the information needed for aggregates planning. Flow charts link processes between focus areas and the data needed for each area are explicitly identified. An information matrix should be established for every planning level.

3.1 Planning Components

Planning for aggregates in a sustainable manner is a complicated issue. Fig 3.1 presents a conceptual diagram of what is involved to reach an informed planning deci-

Figure 3.1: Conceptual diagram for aggregate planning

sion. Raw data are collected from a variety of sources, analyzed in various ways, checked, used for demand analysis calculations and finally implemented into the planning process. There are several feedback connections between the different processes and stages as is expected in a complicated system. A scheme to better organize this information flow is presented below utilizing the concept of an information matrix.

3.2 *Setting up the Information Matrix*

The purpose of this manual is to help the planning authorities of the SEE countries to build up techniques for the effective management of the data necessary for the sustainable planning for aggregates. This may be hard to achieve because it is difficult to compile one single document that will describe the needs of all the countries/regions, due to: i) the heterogeneity that exists among SEE countries concerning data management; ii) the potential lack of tools for the supporting and regulating of aggregates development in some of these countries; iii) the complexity in the existing mechanisms of data collection which is often noticed; iv) the lack of data and information with high accuracy, as well as the lack of methods appropriate for data validation.

Taking into account the situation described above, it is proposed that some basic principles should be set and followed for Data and Analysis for Methodologies for Aggregates Planning, which will be understandable by the planning authorities of all the SEE countries.

1. Reliable information is the sound basis for a successful planning;
2. Aggregates production, use and recycling involve a number of separate activities which may be connected or not and thus sustainable planning should take into consideration all these activities. This means that a wide range of different types of data is needed stemming from the aforementioned activities;
3. It is important to develop a strategy for the collection and a routine for the organization of the above data;

Before attempting to initiate a planning process at any level, the (large amount of) information related to that planning level should be clearly identified.

A tool has been created to help organize this information into logical compartment and to facilitate the identification of aggregate flows between several processes (or focus areas) such as primary production, recycling, etc. Information is provided in a matrix form and includes at least four columns and a variable number of rows. Each

row depicts a process or a phase of the chain, while the columns define the fields which characterize the information in each row. Once the information matrix is completed at a given planning level, then data collection, data validation and data analysis becomes an easy task. Figure 3.2 presents a simplified information structure with seven (7) focus areas or processes and four (4) columns of information.

It is immediately apparent that this matrix takes into account the entire life cycle of aggregate production and ensures a connection between resource and product for a specific region. Each process, or focus area in terms of planning, requires a specific set of data. Focus areas should follow a logical path starting with the extraction process and ending with the disposal of inert materials in landfills.

The matrix is designed in a way to match each process with the necessary information. Each process may have more than one activity towards the same goal, i.e. the extraction process may include blasting, material selection, etc.

In the flowchart column the links between the different focus areas are given which correspond mainly to material streams; these links can subsequently be translated to data types and data needed to complete the material balance for each process. The same links can be used as part of the data validation for a specific data set.

Technical compliance of a product to a specific use is an important parameter that affects material flows and process interconnection. In this simplified information matrix compliance information is not explicitly stated, but can be included in the data set corresponding to each focus area.

As already emphasized this information matrix should be developed for each planning level and should be adapted to the regional characteristics. For example, in a specific region, extraction and production of final products may be considered a single focus area, while in other regions these two processes may be separated. Thus, in summary the following should be considered when constructing the information matrix:

- ✓ each focus area / process should be identified by a specific goal;
- ✓ all activities with a common purpose should be united in single process;
- ✓ the activities which may be undertaken separately should be divided in different processes;
- ✓ focus areas should follow a logical order (from extraction to disposal).

Figure 3.2: A simplified information matrix

3.3 Limitations

The planning authorities are often regional governments that have well-defined geographical boundaries. These boundaries, which correspond to regions or nations, should be considered in the data analysis, although it would be very interesting to apply this concept to neighboring regions linked with common geographical or other features.

Every information scheme or database is as good as the quality of the data that it will manage. Developing an information matrix that cannot really be implemented because of inherent limitations is not considered good practice. For example, some of the following should be taken into consideration when designing an information matrix:

- ✓ In order to ensure that data and processes are representative of the planning level, only data pertaining to areas inside the region should be considered; furthermore, unless a common data scheme is adopted, data collected in different territories within the same administrative region may be different and not consistent;
- ✓ If the planning authority is different from the data-collecting body, then data needs and actual data collected should be homogenized; otherwise results will not help planning.

It is also very important to remember that the whole concept is largely affected by the existing policies of the country and by the administration structure of the state. As a result in each application area a number of issues need to be clarified prior to implementing an information matrix. For example, typical questions that should be resolved are *“what is the state policy and what is the legislative framework for the C&DW waste or for the extractive waste”*.

4. Identification of Data Needs

The provision and use of regular, reliable and up to date data is of utmost importance. The establishment of efficient procedures for data collection, management and data processing is necessary for the development of harmonized SARM (Sustainable Aggregates Resource Management) and SSM (Sustainable Supply Mix) policies. Data provide useful information that can be processed into a more readily accessible form for use by policy makers and decision making bodies as well as the general public. Sustainable aggregates planning, as many other disciplines, depends on good quality, reliable data but planning authorities do not always have the resources and capacity to collect basic data, so in many cases they rely on monitoring and data collection efforts by other agencies. In any case decision making should be based on the best available, scientifically sound data from widely recognized sources. “Perfect” data are not always necessary or possible, but “quality” data are sufficient. Estimations may be used with caution when actual data are not available.

4.1 Introduction

This chapter highlights the main data categories that were identified, the recommended data formats and possible data sources. This chapter was compiled taking into account: 1) information from pertinent published documents and websites, 2) best practices applied in other European countries, 3) information provided by the SNAP-SEE partners and contained in a questionnaire of activity 4.1 of the SNAP-SEE project concerning the data and information collection in each country / region, and 4) the outputs of the SARMa project.

4.2 Data Format

Data may be collected on a national and / or a regional level depending on the level that the planning is applied. Although, the data needed for each task may be different, they can generally be categorized as follows:

- ✓ bibliographical material (including descriptive texts, white papers, and reports);
- ✓ statistical and other tables;
- ✓ maps of various scales and remotely sensed data;
- ✓ thematic information such as networks, infrastructure, etc.

Data can come in a variety of forms such as:

- ✓ paper copies of scientific articles, reports, documents, tables, charts and maps in various scales;
- ✓ digital copies of scientific articles, reports, documents, tables, charts and maps in various scales;
- ✓ paper or digital copies of satellite imagery, aerial photographs or other forms of visual data.

Once the data for a specific task are identified and collected, they need to be compiled, validated and stored. Since establishing “good” data is a very time-consuming process, such data should be preserved and be available to all entities from a single source. Thus data should be stored in a commonly available database for retrieval by authorized users (Fig. 4.1). A database is an organized collection of data that is used to bring together all information about sustainable aggregates planning issues and may also include information about policies and references to other data sources.

A database may be distributed along multiple servers in many locations. It is important to provide seamless service to all queries and to ensure that the database

Figure 4.1: Data flow from collection points to users

has continuity and is constantly updated either manually or by links to monitoring systems. Building such a database is or can be a collaborative effort of various agencies, such as the bureau of statistics, related ministries, regional authorities, national geological surveys and other research organizations.

4.3 Identification of Main Data Sets for Primary Aggregates

Data pertaining to primary aggregates need to include the following:

- ✓ data for safeguarding aggregate deposits and/or operations;
- ✓ data that pertain to the geological distribution and quality of resources;
- ✓ data that describe the current extend of permitted reserves, the rate of depletion through sales, the rate of replacement through new permissions and the resultant landbank(s);
- ✓ data for aggregate sales, production / production capacity, consumption and imports/exports, usually a result of surveys;
- ✓ a directory of active and inactive (permitted) aggregate quarries;
- ✓ data on the operation of borrow pits;
- ✓ data on aggregate transport from the extraction site to the consuming markets;
- ✓ data on the compliance of aggregate resources with technical specifications;

- ✓ data on aggregate demand; this will be the result of demand forecasts scenarios based on appropriate methodologies.

The importance of each of the above data sets is briefly described below.

4.3.1 Data for safeguarding aggregate resources in land use plans

“Land use plans generally contain criteria determining what kind of development can take place in particular areas and are a typical example of plans which set the framework for future development consent” (SEA, 2001). Decision-making for land-use allocation is also based on environmental considerations; examples include nature conservation areas and corridors for species migration, river-basin management and flood alleviation, and soil and water protection.

Policy decisions that define land use are mostly implemented through spatial planning and related functional zoning of land. This involves trade-offs between many sectoral interests, including industry, transport, communication, mining, agriculture and forestry.

An effective safeguarding system requires adoption of “mineral safeguarding areas” and the adoption of suitable policies through which development is managed in these areas. Although primary aggregates are geologically abundant their availability is reduced due to the designation of areas for other land uses. A sustainable aggregates’ policy has to safeguard aggregate occurrences in land use planning in order to avoid any further conflicts. As in many cases areas containing aggregate resources are in contradiction with land use planning.

The aggregates safeguarding maps should hold information on the importance of identified resources on national, regional and local level, by classifying the resources accordingly. The land use planning policy for aggregates should be supported by well-structured and reliable data and must be developed based on the following:

- ✓ a digital geological knowledge base (comprising basic geological maps of 1:50.000. Additional geological surveying might be needed at the scale 1:25.000 to 1:10.000);
- ✓ a transparent methodology for identification of available aggregate resources (quality, quantity, local importance);
- ✓ long term estimates for regional and local demand for aggregates, taking into account other sources (e.g. secondary aggregate resources).

The data could be presented in smaller scale maps (e.g. 1:100.000) depending on the details required and the extent of the respective area covered. The identification of conflict free areas could be done through a GIS based approach. Those resources, proved worth being protected because of quality, quantity and not coinciding with “no-go” or conflict zones in land use, shall be handed over to the responsible planning authorities (national or regional level) for having them declared as raw material safeguarding areas in land use planning.

Two examples of the applied methodology on how to produce an aggregates’ safeguarding map are recommended and can be consulted through the following sources:

- ✓ the Austrian Mineral Resources Plan which was selected by the Commission’s ad hoc group (2010), established under the Raw Materials Supply Group, as a “best practice” example of a national land use policy for minerals (Austria, 2014);
- ✓ the approach followed by the British Geological Survey (BGS, 2012).

4.3.2 Data to improve the knowledge base on the geological distribution of suitable primary aggregate resources

The quantity of aggregates that will be needed in the longer term depends on each country’s state of the economy and the resulting level of construction activity, as well as the future availability of resources for investment in infrastructure.

Knowledge about aggregate resources is essential for making effective and sustainable planning decisions. Efficient and effective functioning of the planning system depends on high quality, readily accessible information on the extent, quality and, if possible, quantity of mineral resources and their relationship to national planning designations, which might represent constraints on the extraction of minerals. This information is important for the production of mineral development framework documents, both in the context of identifying areas of future mineral working and the longer-term objective of minerals safeguarding by protecting important mineral resources against sterilization.

A primary objective is to produce baseline data in a consistent format that can be updated, revised and customized to suit planning needs, including for use in the preparation of Mineral Development Plan Documents and Regional Spatial Strategies.

Identifying aggregate resources requires understanding of the location, scale, type and accessibility of the resource. Approaches used to identify aggregate resources vary in their level of detail and scale depending on the needs, pressures and availability of aggregates in an area. A common approach is to identify the aggregate resources in terms of its geological components and scale (recommended map scale 1:50.000). Maps developed in this scale can usually only include information about the surface extent of the aggregate resources, general quality characteristics, and areas with mineral exploitation potential. National Geological Surveys are usually the data providers of such information i.e. on the quality and quantity of aggregate resources.

Identification of strategic aggregate resources should also identify other key factors that may affect access to and viability of, an aggregate resource in relation to its location and surrounding land uses. Therefore it is important that the regional/local planning authorities collect and compile all different levels of information on a map (recommended scale 1:100.000), with the use of GIS tools, that will be regularly updated. Four major elements of information could be presented on these summary (output) maps:

- ✓ the geological distribution of all onshore aggregate resources and the location of aggregate extraction sites
- ✓ the extent of mineral planning permissions
- ✓ the extent of selected landscape and nature conservation designations

The impact of the mentioned restrictions regarding the access to aggregate resources and the supply of quality aggregate products should be periodically (e.g., every 5 years) surveyed by the respective public administration, in cooperation with a range of interested stakeholders (e.g. industry, NGOs, local communities and authorities) and if needed corrective measures and alternative options should be adopted.

4.3.3 Data to assess the current extend of permitted reserves, the rate of depletion, the rate of replacement and the resultant length of landbanks

For planning purposes a landbank is commonly quoted for aggregate minerals. A landbank is the sum of all permitted reserves (in active and inactive sites) at a given point in time and for a given area. It is usually expressed in terms of years supply at an average rate of output. The area under consideration usually corresponds to an individual Mineral Planning Authority (MPA) or group of MPAs. Landbanks provide an indicator of the degree of need for new permissions to be granted. The minimum length of a landbank reflects the time needed to obtain planning permission and to bring a site into full production. Given that the process of planning permitting and

startup of aggregate operations may take up to several years, it is recommended that landbanks should provide sufficient reserves for at least the next 20 years.

Planning authorities should ensure a landbank of permitted reserves for aggregates. Where market areas for aggregates extend across local authority boundaries, authorities should work together to ensure that an adequate supply of minerals can be provided. This is particularly important in the city regions.

It is important that stakeholders, including the aggregates industry engage in consideration of landbank issues. New consents should not be permitted if they are in locations which, in planning terms, are unsuitable or which lead to landbanks significantly in excess of market requirements. The need to identify areas of search may be obviated by accurate data on landbanks, but should be reviewed in line with development plan schemes. The scale of the landbank should be set out in the local development plans.

4.3.4 Data on aggregate sales, production / production capacity, consumption and imports/exports

These surveys (compiled every 4 year intervals) should provide in-depth and up to date information on the national and regional sales, inter-regional flows, transportation, consumption, production and permitted reserves of primary aggregates. Such data are usually supplied from official sources (e.g., planning authorities) and operating companies and should be regularly updated. Units of measurements are tonnes. Values should be provided for imports/exports and sales. The surveys should be used to inform the authorities on the production, transport and consumption of primary aggregates in order to monitor and revise the aggregates guidelines and to monitor and develop planning policies for the managed supply of primary aggregates in each country / region.

4.3.5 The directory of active and inactive (permitted) aggregate quarries

A database of active and inactive quarries should hold information on:

- ✓ the status of the quarry (active or inactive);
- ✓ the name of the quarry
- ✓ the geographic location (coordinates);
- ✓ the quarry address;
- ✓ the operator;
- ✓ the geology (based on a 1:50.000 geological map);
- ✓ the production figures per product (tonnes);

- ✓ the production capacity (tonnes);
- ✓ the product end-uses where known;
- ✓ the sales tonnage;
- ✓ the expiration date of the quarry permit;
- ✓ the total resources / reserves;
- ✓ the remaining resources / reserves;
- ✓ the production figures for the previous 3 years (applies to temporarily inactive quarries).

The database and its associated GIS record will provide a valuable tool for monitoring among others the production capacity, reserves and resource depletion.

4.3.6 Data on borrow pits

Small workings, sometimes called borrow pits, commonly associated with road construction, forestry or agriculture, allow for the extraction of minerals near to or on the site of the associated development. Other than within the scope of permitted development rights, those workings will require planning permission in the normal way. The availability of primary aggregates generally, may overcome the need for such workings so applicants will need to demonstrate the particular operational, community or environmental benefits of such proposals. They should be time-limited consents, tied to the particular project and accompanied by full restoration proposals (SPP, 2006).

4.3.7 Data to assess the impact of the transport of aggregates from the extraction site to the consuming markets

A Transport Assessment, submitted in support of an application, should assist the planning authority in coming to a view on the development's transport impact. Aggregates used in construction, are generally not transported more than 50 km by road, before they become uneconomic, although higher value minerals may serve more distant markets. Where there are significant transport impacts on local communities full consideration should be given to the provision of routes which avoid settlements. Where rail, coastal or inland shipping are not viable alternatives to road transport, the key issues are usually related to site access, vehicle control and monitoring under the conditions of the extraction site's planning permission.

Where feasible, new sites should be guided to locations close to major urban areas which are the main markets thereby contributing to reducing heavy vehicle traffic, road wear, energy consumption and environmental pollution.

4.3.8 Data on compliance of aggregate resources with technical specifications

All aggregates (primary and secondary) must meet certain prescribed minimum standards if they are to be used in the construction sector. They should fit for purpose under an attestation of performance, or should comply with relevant national or EU standards. To ensure aggregates continually meet the required specification, and thus to ensure the end product is suitable for its intended use, a series of laboratory tests have been devised. A full list of the tests established by these new European standards are given below. The appropriate Standard document should be consulted if the full details of the tests and methods are required.

EN 932 Tests for general properties of aggregates

EN 933 Tests for geometrical properties of aggregates

EN 1097 Tests for mechanical and physical properties of aggregates

EN 1367 Tests for thermal and weathering properties of aggregates

EN 1744 Tests for chemical properties of aggregates

There are also European standards that specify the range of acceptable values under each test. Aggregates should fall within these ranges to be considered suitable for that use. The relevant standards are:

EN 12620 Aggregates for concrete

EN 13043 Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas

EN 13055 Lightweight aggregates

EN 13139 Aggregates for mortar

EN 13242 Aggregates for unbound and hydraulically bound materials

EN 13383 Armour stone

EN 13450 Railway ballast.

4.3.9 Data to support demand forecasts

Aggregates demand is driven by activity in the construction industry and the economy as a whole. According to UEPG (2013) about 30 kt of aggregates are needed per km of new road. Therefore, demand forecasts play an important role in national and regional policy formulation and are used to determine medium and long term supply requirements. If a national or regional government can estimate the future or near future demand for aggregates “it can formulate aggregates policy accordingly” and consider what proportion of the demand should be met by the key sources of supply. Different forecasting methods may be used including simple extrapolations based on historical trends, through to more sophisticated forecasts that are focused on construction based economic data and their interrelations (see chapter 5).

4.4 Identification of Main Data Sets for Secondary Aggregates

Several types of mineral by-products waste and residues can be effectively turned into secondary products through recycling. These products can be used in substitution of or in mix with natural aggregates (i.e. aggregates from mineral resources which have been subjected to nothing more than mechanical processing), for several end-uses, saving at the same time non-renewable resources and scientifically reducing land take and subsequent environmental impacts. Sources of secondary aggregates have a strong regional character (Blengini et al, 2013).

Four types of recycling activities are considered as potential sources of secondary aggregates and these are illustrated in Table 4.1. Data pertaining to secondary aggregates need to include the following:

- ✓ Data for technical specifications;
- ✓ Data for environmental impacts;
- ✓ Volumes and percentages per type of secondary resources produced;
- ✓ Volumes and percentages per type of recycled secondary resources;
- ✓ Volumes and percentages of recycled material used as aggregates replacing primary aggregates.

4.4.1 Data on technical specifications

The same European standards that apply to primary aggregates (see section 4.3.8) also apply to the secondary aggregates resources. The standards are based on the aggregates fitness for purpose rather than the source.

4.4.2 Data on environmental impacts

Secondary aggregate resources processing activities, expansion to current sites and change of use of existing sites require planning permission and environmental permitting. Their processing produces dust, noise and may generate soil and water pollution if not properly managed and their transport to the processing site and of

Table 4.1: Classification of recycling activities as potential sources for secondary aggregates production (Chalkiopoulou & Hatzilazaridou, 2011)

R1:	Recycling of by-products, waste and residues from extractive activities
R2:	Recycling of Construction & Demolition Waste (C&DW)
R3:	Recycling of excavated soils / rock from civil works
R4:	Recycling of industrial waste (e.g. slags from ferrous metal production, bottom ash from municipal solid waste incineration, ash from coal combustion)

products to construction sites also have environmental impacts associated with them, for example carbon emissions and noise. Before processing is applied, they are still classified as waste; therefore processing facilities operate under waste management regulations as applied in each country (SA, 2014).

4.4.3 Data on volumes of secondary resources

Only a portion of secondary resources may be suitable for aggregate use. For sustainable and effective aggregate planning, it is important to collect information not only on the produced volumes (recovered and recycled) but also on the percentage utilized in place of primary aggregates in the SSM.

The inert extractive or mining waste (R1) may become, after treatment, a potential aggregates resource. Since inert wastes may become aggregate resources, the compilation of dynamic inert waste lists can promote the development of integrated waste management schemes. Also, according to the criterion (d) of the Commission Decision 2009/359, mining waste is considered as being inert waste only if its content in heavy metals is sufficiently low and does not exceed “national threshold values for areas characterized as being non contaminated or relevant national natural background levels”.

Construction & Demolition Waste (R2) are generated during building and public infrastructure construction activities, building and infrastructure demolition and road repair works. The specific waste stream was identified as a priority by the European Commission, since it constitutes one of the largest waste streams, representing almost 50% of the total waste produced in the European Union (EU). Currently, this type of waste is covered by the Directive 2008/98/EC on waste (that repealed the Directive 2006/12/EC). The recycling of C&DW is accomplished through permitted recycling facilities (fixed or mobile plants).

Excavation waste (R3) generated from civil works are sometimes used in place of primary aggregates. This, however, is in direct (and often unfair) competition to permitted aggregates operations, since their production is not subjected to fees and royalties and/or reclamation expenses. The origin of such waste should be carefully investigated before they are allowed in the supply mix.

Industrial waste (R4) may originate from various industrial processes. Slag is a common industrial waste and is used both for the production of cement, and as aggregate as well.

The estimation of the percent of C&DW which is recycled is usually based on the

quantities managed by the recycling facilities. Also, the estimation of percent recycled C&DW used as aggregates is usually based on the quantities sold.

4.5 Examples of Data Forms for Data Collection

In this section a number of tables or forms useful for data collection are presented. The forms should be tailored to address either information on specific data set as presented above or specific focus areas or processes as presented in Chapter 3.

Geological Resources

Administrative Planning District (i.e., Region, State)	Location Coordinates	Formation Type	Map Scale	Reserves	Estimate of Technical / Quality Characteristics	Responsible agency

Geological Reserves

Administrative Planning District (e.g., Region, State)	Location Coordinates	Formation Type	Map Scale	Reserves	Technical / Quality Characteristics
e.g., Resource Zone, Quarry, etc.					

Permitted Reserves

Administrative Planning District (i.e., Region, State)	Location Coordinates	Formation Type	Map Scale	Reserves	Technical / Quality Characteristics	Permit Holder
e.g., Resource Zone, Quarry, etc.						

Primary Aggregates

Quarry or Pit Information (Active & Inactive)	Quarry Location (Coordinates)	Year Start of Permit	Year End of Permit	Type of rock Formation(s)	Technical Characteristics (#)
1.				e.g., limestone, igneous rock, etc.	e.g., chemical, mineralogical composition, Los Angeles and compressive strength, etc.

(#) per recommended application

Active Quarries for Primary Aggregates

Production Center (*)	List of Active Quarries	Year of reporting	Annual Production (tonnes) (**)	Current Capacity (tonnes)	Remaining Reserves (tonnes)
1	1.1				
	1.2				
	1.n				
2	2.1				
	2.n				

(*) Depends on the Level of Planning, e.g. District, Quarrying area, Region, Municipality, Quarry, etc.

(**) per produced size

Inactive Quarries for Primary Aggregates

Production Center (*)	Number of Inactive Quarries	Year of reporting	Current Capacity (tonnes)	Remaining Reserves (tonnes)

(*) Depends on the Level of Planning, e.g. District, Region, Municipality, Quarry, etc.

Land Use Planning

Identification of extraction areas	Location Coordinates	Identity of responsible agency
Areas where extraction is not allowed		Local/regional Government
Areas where extraction may be allowed under conditions		
Extraction is permitted		
Resources are safeguarded		

Environmental Impacts due to proposed aggregate planning

Monitoring of air quality near operating units		
Monitoring of water quality near operating units		
Other environmental constraints		

Secondary Production for Mining / Extractive waste / byproduct / residue (R1)

Secondary Aggregate Facilities (quarry, mine)	Facility Location (Coordinates)	Year Start of Permit	Year End of Permit	Type of Product(s)	Technical Characteristics (#)
1.					e.g., chemical, mineralogical composition, Los Angeles, compressive strength, etc.

(#) per recommended application

Secondary Aggregate Production for C&DW (R2&R3)

Secondary Aggregate Processing Facilities	Facility Location (Coordinates)	Year Start of Permit	Year End of Permit	Type of Product(s)	Technical Characteristics (#)
1.					e.g., chemical, mineralogical composition, Los Angeles, compressive strength, etc.

(#) per recommended application

Active Facilities for Secondary Aggregate Production

Facility (*)	List of Active Facility	Year of re- porting	Annual Pro- duction (tonnes) (**)	Current Capacity (tonnes)	
1	1				

(*) Depends on the Level of Planning, e.g. District, Quarrying area, Region, Municipality, Quarry, etc.

5. Analysis Methods

Actual information is better than estimated values; reliable information is the basis of a successful aggregate planning scheme. Obtaining actual and reliable information constitutes a major effort. At the same time, data validation is a necessary step in order to ensure the reliability and accuracy of the collected information. Demand forecasting, which is the cornerstone of all the planning activities, should be based on accurate and reliable data. Demand forecasts may be performed by a variety of methods, depending on the available data, and should be revised regularly to reflect changing economic conditions.

5.1 Introduction

Data collection and storage constitute major efforts that are undertaken because information is needed to support aggregates management and policy planning. The analysis of data can be divided into three broad categories: quality control, interpretation, and prediction. Quality control is necessary because mistakes and omissions can occur in data collection processes, e.g., due to coding errors or misreporting. In addition, it is sometimes necessary to use estimated values, even though actual information would be preferable. Thus, quality control through data validation is a necessary step in order to ensure that information is as reliable and accurate as possible.

In many instances, validated raw data provide the necessary information. However, considering the data in a market context can also be useful. One approach is to analyze the material flows throughout the aggregates sector. This is sometimes included as part of the data validation process, but can also increase understanding of how to utilize resources more efficiently. Data can also be analyzed in simple or complex models so as to better understand past and anticipate future conditions. One of the most important categories of predictive models used in planning is demand forecasting, which provides essential inputs to decision making.

5.2 Data Validation

As previously explained, in order to reduce the gap between production and effective demand i.e., the amount that is expected to be used, it is important that the information and the data used for the planning phase should be as reliable as possible, and that they should mirror the territory taken in consideration. For this purpose, a data validation analysis should be done in order to confirm if quality requirements of data (for the usage that is expected) can be satisfied.

Hereinafter, some starting points about data validation will be illustrated, with particular reference to the scheme in Figure 3.2. Essentially, the validation process can be realized horizontally and vertically, depending on the goal of the validation process, but also depending on the final use of the information.

The horizontal validation consists of a check of input data from questionnaires, plans, projects or statistic forms from which data are collected and organized. Its continuous upgrade and improvement represents an essential element in order to enhance the reliability of data and consequently the consistency of the results of data analysis.

Carrying out a horizontal validation means a check of the data plausibility and, if necessary, the correction of possible errors. Moreover, it is a very important step in the life cycle of statistical data, because it influences the reliability of the final result of the analysis. In this perspective, it can be useful to establish some Data Quality Goals (DQGs), meaning the desirable characteristics of the data needed for the study or the specific sector for which data are collected (for instance time coverage, geographical coverage, precision and completeness, source of the data, uncertainty of information). Some specific Data Quality Indicators (DQIs) can be used for establishing the quality of the available data, but also thresholds of weighted values may be used.

Looking at the scheme in Figure 3.2, horizontal validation concerns information of a Focus Area (or specific process units), for instance the extraction phase or C&D waste recovery.

Generally speaking, the validation process includes three main components: data editing (such as the identification of missing or inconsistent values/entries), management of missing data by imputation (such as the correction of missing data, usually caused by total or partial non-response, throughout imputation and reweighting methods), and advanced validation (such as the improvement of data quality using advanced statistical methods).

Vertical validation concerns the input/output flows into/from a specific process unit. In this way, it will be possible to keep track of the materials that are included into a transformation process and identify possible stocks and losses. More specifically, this type of analysis is based on mass balances or the material flows that move from one process unit to another (Figure 5.1). These mass balance equations take into account the amount of the input material into a specific process unit (defined in detailed through the system boundaries identification (Blengini et al., 2014), the amount of the output material of the same process and the eventual stocks (materials that remain into the system for a period and that shouldn't be considered as a waste or a loss). Any error in this sense, will cause a final balance not equal to zero, which means the planning phase of mining activities will be more difficult.

So, the first step deals with identifying the elementary processes and flows of the system under analysis. The correlation between input and output represents the step of data validation because if the mass balance is not null, it is immediately evident whether there is a lack concerning the availability of data or their accuracy.

$$\Sigma(\text{Input}) = \Sigma(\text{Output}) + \Sigma(\text{Stock})$$

Figure 5.1: Example of the link between different process units through material flows

With such a process, it is possible to establish the links between one or more Focus Areas. This can be helpful in order to have a wider vision of the aggregates life cycle (from-gate-to-gate). Moreover, in this way it is possible to identify the main gaps in the unit system and, consequently, of the collection process. In relation to the error, it is thus possible to establish a focused intervention for future campaigns for data collection and/or management improvements in terms. Some specific examples can be found in the case study on Trento (Blengini et al., 2014).

The integration between these two validation procedures can support identification of gaps in the information structure and therefore, the establishment of some priorities about data retrieval, particularly if it is possible to highlight any information gaps and/or a strong divergence between the same type of data that have been collected from different sources (for example, the output of one process and the input to the next). Depending on the final use of the information and on the planning level, it is possible to address the efforts to a more detailed data retrieval, for example enhancing the data collection structure and the collaboration between the stakeholders.

5.3 *Material Flow Accounting and Analysis*

Material flow accounting (MFA) uses the principle of mass balancing introduced in the preceding section to study how materials and energy flow through the economy and the environment within countries and among countries. The principle is founded on the first law of thermodynamics (called the law of conservation of matter), which states that matter (mass, energy) is neither created nor destroyed by any physical process. The purpose of MFA is to enhance tracking of material and energy flows through an economy and into the environment, as well as to increase understanding of how to make the most economical and resource efficient use of materials. MFA tracks the movement of matter into and out of a system of interest, in this case the aggregates sector, using methodically organized accounts and denoting the total amounts that remain for a defined period to create a stock.

Material flow analysis is the systematic assessment of the flows and stocks of materials within the system of interest within a defined space and time. It uses data from MFAs to deal with specific problems, such as controlling pathways for materials use and industrial processes, promoting the dematerialization of industrial output, or determining how much of the aggregates required to sustain the economy can be supplied from domestic sources. The results of material flow analysis can thus contribute to policy analysis and planning.

5.4 *Demand Forecasting*

Demand for aggregates is derived from the demand for final goods and services in the economy, such as housing and transportation. Drivers of increased demand include population growth, increasing standard of living, new or expanding uses, and economic growth. Drivers of decreased demand for aggregates include higher costs that lead to higher prices, increased efficiency, economic conditions such as recessions, and decreasing intensity of use (tonnes per unit of GDP), which is typical in mature, developed economies. One additional potential cause of decreased demand for primary aggregates is substitution, including substitution with recycled materials.

A demand forecast can be based on expert judgment or on a quantitative model of some form. Every model will have its own level of complexity and detail, underlying theory, and implementation method. Those based on sectoral characteristics are termed bottom up models; those based on intensity of use are called top down models. Sectoral models typically represent either a hypothesized causal relationship, or are a trend extrapolation of a series of observations collected over time, i.e., time series data. The former are modelled with one, or a set of, econometric regression

equations that assume demand depends on one or more independent explanatory variables, e.g., economic activity or population. The latter assume that the pattern of past demand will continue into the future.

5.4.1 Causal demand forecasts based on local land use planning

This estimate can be obtained indirectly on estimated volumes, taking into account both the previous and the ongoing or planned infrastructural works (private buildings and public works). Their maintenance, renovation and restoration should be considered. The aggregates demand volume (Vest) is modelled as a function of area and a spatial index. Virtually all statistics are reported in tonnages, so utilizing this method would necessitate converting tonnages to volumes.

$$\text{Vest} = (\text{Sha} - \text{Ped}) * \text{It}$$

where Sha is the surface of homogeneous areas [m^2], Ped is the surface of the built-up areas [m^2], and It is the spatial index [m^3/m^2].

The volume obtained in relation to the built-up areas is multiplied by the corresponding coefficients of utilization, i.e., the amount of aggregates per unit of volume. Thus, the amount of materials necessary for executing the planned works and the maintenance of existing buildings can be obtained.

This methodology can be difficult to apply because it is based on the assessment of the needs of local urban planning, and in particular on the estimates of the local strategic plans, which specify the expected new construction in future years. However, the assessment based on the local planned works usually provides an oversized estimate, since it is based on the assumption that the local strategic plan will be fully implemented, a condition that often does not usually occur due to different reasons.

In addition, this methodology approximates the proportion of built-up volumes subject to maintenance, renovation and restoration. Finally, a limitation of this methodology is that it neglects the consumption related to some public works, such as those concerning roads, works for industry and for morphology of the territory, which may change (perhaps significantly) the material requirements.

5.4.2 Causal demand forecasts based on population or economic activity

The first of these approaches assumes that demand for aggregates is a function of population levels. The current volume of aggregates consumed per capita (m^3 / inhabitant) can be calculated as total production divided by population. A population

growth projection is derived from national statistics, though it should be considered as an approximation because it represents a national average. If population is expected to remain steady, demand will be constant. If population is expected to grow, then demand will grow in proportion. This method assumes that consumption levels will continue to increase as they have in the past. In general, this method does not take into account the market or demand trends, and thus can easily under- or over-estimate future demand (Cabini & Zobolu, 2011). It should be noted again that, since all statistics are reported in tonnages, utilizing this method would necessitate converting tonnages to volumes.

A similar simple regression approach is based on the assumption that demand is a function of the size of the economy; if the economy is growing, demand for aggregates will increase and vice versa. Historically, gross domestic product has been a reasonably good predictor of demand for aggregates, but this is not always the case. First, it is only effective as long as intensity of use is increasing because there is an underlying assumption that as the economy grows, demand will grow. However, once intensity of use begins to decline, economic growth will lead to less rather than more consumption. Second, the relationship does not take into account the use of substitutes, such as recycled Construction and Demolition Waste (C&DW).

It is also possible, though less common, to construct more complex models of the relationship between economic activity and demand. An econometric model of the economy could be created based on a set of linear or nonlinear equations that are solved simultaneously, such as is done in computable general equilibrium models. Or, a demand forecast can be generated by the use of system dynamics modelling simulations. The crucial parameter arrays in the interrelations of stocks and flows in the economy are the economic benchmarks of gross domestic product (GDP) and population, though other relationships can be included as well.

5.4.3 Time series forecasts based on production statistics

“Official” statistical data regarding the production of aggregates are often used for planning. Using these data, if and where available, as a proxy for demand assumes that local production is mapped directly to local needs. This may lead to erroneous forecasts for several reasons:

- In areas where the percentages of importing and exporting of aggregates are significant, historic production levels will not reflect local demand;
- Production statistics, as provided by local and national authorities, do not have a high degree of reliability and often do not take into account the different types of materials; and

- In such cases, the type of material needed cannot be estimated, and thus a SARM scheme cannot be developed.

Assuming that production statistics are available, a general trend for aggregates production can be estimated after the annual data are filtered and errors removed or reduced. Methods such as exponential smoothing and moving averages can be utilized to prepare the data for linear or nonlinear trend fitting and extrapolation. This analysis may give an indication of the average production for the coming years. The main characteristics of the total production system are assumed to be reflected in the data, though the influence of independent causal factors (temporary or long term) are not directly considered. These include factors that affect production, such as local and regional economics and taxation.

It is very important that the trend data be updated on a regular basis by continuously monitoring of activities and comparisons with the results of previous forecasts. This is particularly important since some data may pertain to a crisis period which will not accurately forecast possible increase demand in the years following economic recovery. This approach can be useful as a cross-check with market demand estimated using a causal model, but is not adequate for a correct estimation of the actual aggregates demand relationship (Cabini & Zoboli, 2011; Mazzanti et al., 2007; Worcheshire County Council, 2013).

5.4.4 Time series forecasts based on consumption statistics

The forecasting approach here is methodologically similar to that in the preceding section. It is based on actual aggregate consumption values for a given region over time and on the continuity principle, i.e., that future consumption can be estimated as an extrapolation of current and previous consumption data. The results should be revised and updated by also assessing any important new construction projects in comparison to past practice, e.g. any planned works that have already been funded.

Using historical consumption data (usually 5 or 10 years) for this analysis, it may be possible to derive medium-term trends that (after adjustments) can provide a demand forecast. The difficulty in this case relies in the availability of consistent, reliable and statistically sound information. As an example, in most cases, aggregate consumption statistics per end use are not available, thus again planning using the SARM principle may be not be feasible. When some data are not available, some estimates can be obtained indirectly by utilizing consumption data of other materials that are utilized together with aggregates (primarily cement), or perhaps statistics of production costs about completed (public) works. Often, aggregate consumption can be evaluated through specific utilization coefficients.

The gross volume utilized in civil works can be divided into two categories (a) aggregates used for the construction of buildings and public (infrastructure) works and (b) aggregates utilized as subbase material. In the case of buildings, consumption estimates may be developed by indirectly assessing the relative quantities, i.e. based on the volumes reported in construction licenses where available. In the case of buildings, aggregate consumption is related to building volumes, surfaces, number of floors, etc.

Public works mainly service residential areas, and, therefore, it can be assumed that they are proportional to the building volumes or areal extends. Sometimes, it is also possible to calculate the ratio between the materials used in public works and in buildings. Since in most cases, direct data about the consumption of aggregates in public works are not available, expenditures can be used as a reference parameter. Such expenditures may be related to construction, maintenance, renovation and restoration. In general, two large types of public works can be distinguished: a) civil and industrial buildings and b) roads, highways, viaducts, railways, bridges, subways, funiculars, airport runways, and related complementary works.

Also, by comparing historical data on buildings and public works in relation to the total volume of aggregates that have been produced from quarries and alternative sources, it is possible to define utilization coefficients that are suitable for the specific case and period under examination. Obviously, these coefficients are related to the building types considered and take into account the use of aggregates for the construction of such a building (foundations, bearing structure, etc.). A different set of coefficients should be used for appraising the amount of aggregates used for auxiliary works in the main building structures.

A variation on this approach is used in the United Kingdom, where aggregates consumption is forecast based on trends in relatively more aggregate-intensive uses (house, infrastructure), relatively less aggregate-intensive uses (housing repair, industrial) and intensity of use. These data are smoothed and averaged as appropriate and necessary, after which ordinary least squares regression is used to fit the data trend. As with all times series analyses, forecasts assume that historic relationships will hold into the future, so it is essential to update forecasts at least every 6 months to capture changes (UK Gov, 2014).

6. Recommendations

General recommendations are given in this section. Individual countries and regions should adapt these recommendations to better fit their planning process.

6.1 General Recommendations

A number of general recommendations are presented below regarding the data and data analysis needed for sustainable aggregates planning.

- Demand for aggregates in the SEE region should be addressed with a mix of primary and secondary aggregates (e.g., recycled construction and demolition waste, manufactured aggregates, excavated materials from civil works, etc.) according to resource efficiency principles. In fact, multiple sources of supply can contribute to satisfy demand.
- Planning authorities should identify available mineral resources that meet the quality, accessibility and technical requirements for aggregate resources in their area when preparing development plans.
- It is important for SEE countries / regions to adopt and implement a land use planning policy for aggregates in order to promote investment in extractive industries.
- A sustainable minerals policy for aggregates should safeguard aggregate occurrences and land use planning should allow for future quarry operations in these areas. Land use maps should be available on a national, regional and local level.
- All of the concerned stakeholders, e.g., those responsible for land use planning or for regulating the planning process of primary and recycled aggregates and the sustainable use of natural resources as well as industry, local communities, NGOs and civil society should work in close cooperation.
- Aggregates planning should be revised at preset time intervals to ensure that it is up to date with current requirements, the legal framework and other constraints.
- SEE countries / regions should consider exchanging data on aggregate planning in order to explore possibilities of imports and exports between neighboring countries.

6.2 *Recommendations on Data and Data Analysis Methodologies*

Specific recommendations on how to improve data collection, validation and analysis are presented below:

- Efficient procedures for data collection, management and data processing should be established for the development of harmonized SARM (Sustainable Aggregates Resource Management) and SSM (Sustainable Supply Mix) policies.
- Decision making should be based on the best available, scientifically sound data from widely recognized sources. Data should be thoroughly checked and validated before processing.
- Regular surveys should be conducted that provide in-depth and up to date information on reserves and resources, consumption and production volumes, inter-regional flows, transportation, permitted reserves of primary aggregates, on a national and/or regional scale depending on the level of planning.
- An information matrix should be constructed for each level of planning identifying the processes and data sets required for each process.
- Demand forecasts should be completed using the most suitable methodology in each region / country. Information should include public works, the private sector, exports, etc.
- All data should be organized in an electronic database which should be regularly updated. As an example, a directory of active and inactive (permitted) aggregate quarries, along with installed production capacity should be maintained in the database.
- Data should be validated in order to ensure the reliability of the information.

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