# Greek marble by-products – Limitations and Opportunities

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**Abstract**

Marble has had a series of crucial applications in our lives for the past 2.500 years. More specifically, Greek deposits are notable and so far marble has been inciting the market and powering the economy. Also, the development of the applied technology gives us the opportunity to widely use the marble by-products, in the output of a series of products. However, when extracting a good quality marble block, the volume of sterile exported is enormous and respectively the waste of raw material and the environmental footprint are significant.

The aim of this article is to identify the administrative and legal problems which prevent the adequate utilization of marble by-products and propose the establishment of small spatial units, based on the principles of industrial symbiosis. The implementation of industrial symbiosis includes the utilization of the mined raw material, with the minimum energy and matter waste.

The necessity of the production's vertical integration is not only obvious, but absolutely necessary, yet combined with the development of a symbiotic relationship between the marble enterprises, in order to cut down the cost and protect the environment. The government should motivate enterprises to undertake the process of by-products in units close to quarries, action from which the benefits will be multiple, the major of which would be the companies' stability, the new working positions and financial gains in a field that continues to flourish. If all the information mentioned above are to be added to the extremely difficult economic situation of our country and the significantly high interest in Greek extracted material, one can easily understand the necessity of the proposed measures and the numerous benefits that the local communities and the country as a whole can obtain.

## 1. INTRODUCTION

The quantity of the Greek marble products is that large, that Greece is considered as a leading marble producer and exporter, especially in the last 20 years. There are many exports of Greek marble products, consequently contributing significantly to the GDP. Dolomite and limestone deposits are of unique quality and shades, placing them very high in preference to the foreign markets.

Despite the fact that marble is a quarry product synonymous to Greek culture and its economic development from the ancient times, nowadays, the marble process is incomplete and does not meet the full potential, proportionally to the wealth stocks. Specifically, most products are exported as raw material, completely unprocessed, abroad and especially to China. This is happening due to the duties of processed products and the small number of businesses able to undertake the process of both products and by-products.

Unfortunately, most of the times, barren materials end up abandoned outdoors, despite the serious bans about the deposition of such materials in the natural environment. It is noteworthy that there has been no indication of old, or authorization and creation of new positions for the reception of the barren materials. As a result, quarries face serious transportation and deposition problems, as well as the degradation of the natural environment. Nonetheless, the deposited materials can be processed,

using the appropriate technology that enables the use of marble blocks and other by-products in a lot of other uses. The utilization of by-products may refer to building materials, restoration and reclamation of quarries, landfills enrichment, and creation of mortar, production of feedstuffs or soil improvers, even innovative products (e.g. synthetic objects from marble).

## 2. METHOD

Aiming to determine the barriers posed by the Greek legislation and administrative practice towards the adequate utilization of marble by-products, the market value of the products and the applications of marble-products in Greece were investigated. Greek legislative framework as well as the institutional tools related to marble mining legislation and siting quarries were also examined and are presented thoroughly below. Moreover, the waste management issues and their connection with the by-products have been taken into close look. Finally the requirements of industrial symbiosis and its applicability in the case of marble products were investigated.

The information were collected through Greek and foreign literature. Additionally, in order to have a clear view of both deficient laws and administrative practices, interviews with officials of the Ministry of Reconstruction of Production**,** Environment & Energy, scientists and representatives of the marble industry were conducted.

## 3. MARBLE PRODUCTS & BY- PRODUCTS

### 3.1 Marbles

Marbles are metamorphic rocks originated from sedimentary carbonate rocks, mainly limestone. As for the mineralogy, they are mainly consisted of calcite and dolomite. The Greek term means shiny stone, which explains the commercial naming, where marbles are a series of rocks, like limestone, dolomite, serpentines or some conglomerates that can be cut and smoothened. The most important Greek marbles are the white marble of Pentelis and Dionysus, the white to semi-white marbles of Drama-Kavala-Thasos area, Naxos marbles and the pink marble of Pillion.

The marbles' extraction is performed mainly using a surface method of cutting the material with the aid of helical wires. The helical wire is a continuous loop of tensioned steel that moves at a speed of 5 to 6 meters per second and cut the marble at a rate of 20 centimeters per hour. By all means, the procedure is carried out according to the working regulations, so as safety and reasonable exploitation are guaranteed. The difference between marble and raw materials' extraction is big, since there is no use of explosives and this reflects to a visible change in the landscape as well.

Marbles' industry is a traditional and essential factor in national economy, having a dominant position in the world market, despite the adverse circumstances, the fierce world competition and the restrictions on environmental issues. Namely, on a major marble's use like the decoration stones, a sector that Greece is showing a great flow of exports for decades, the country ranks 11$^{th}$ globally from 2004 till now. This is one of the few sectors that Greece intertemporaly competes with the global markets, especially when the leading countries are huge and multitudinous countries with a great workforce and rich ground, like China, India, Italy, Spain, Turkey, Brazil or the USA. In particular, Greek marble managed to maintain its position in world markets due to its great quality and unique physical and technical characteristics. Nowadays 40% of the exported material is headed towards China while the rest of it ends up in the Middle East, the USA and a smaller part in Europe (Tzeferis, 2014). In 2013 the exports in the marbles sector were over 850.000 tons and over 240 m. € in value, confirming the rising trend from the start of the financial crisis (Hellenic Statistical Agency).

Another key number is that 75-80% of the total production is exported, with the shrinking of the internal interest to be constant (Tzeferis, 2014). This is the reason focusing on the China status is important. It represents the major market for Greek marble, with 477.300 tons of exported material with a value of 98,6 m. €, or 58,35 of the total amount with the 42,5% of the total value, heading to the other side of the planet. Unfortunately, China imports unprocessed blocks of marble, resulting in the deterioration of the additive value and loss in our public income due to the difference between processed and unprocessed material in terms of tax policy. As a result, only 21% of processed and 67% of unprocessed marble blocks is exported.

As far as the imports are concerned, for the past 5 years they show a great decrease, due to the internal crisis and the low demand of construction materials.

### 3.2 By-products

The Waste Directive Framework (2008/98/EC) defines as by-product "A substance or object, resulting from a production process, the primary aim of which is not the production of that item". By-product may be regarded as not being waste (any substance or object which the holder discards or intends or is required to discard) but as being a by-product only if the following conditions are met:

- further use of the substance or object is certain
- the substance or object can be used directly without any further processing other than normal industrial practice
- the substance or object is produced as an integral part of a production process
- further use is lawful

According to the above, as marble by-products are considered sterile products, whose utilization may arise aggregates as main marketable product with use in the production of cement and concrete, material 3A which is mainly used as an improvement substrate to the underlay of low traffic roads, the crushed stone and marble powder. (Technical Chamber of Greece, 2004)

Marble powder has many industrial uses because of its very fine limestone grains and its low content in metal oxides. The usage of marble powder includes its use as agricultural soil amendment and cement production (Misra & Gupta, 2008; Marras et al., 2010). Other applications of marble powder are in the desulfurization of flue gas in power stations (Fraes, 1994; Marras et al., 2010), the production of soda, lime, resin conglomerate for floor, coatings in the building industry, as well as a host of chemical applications, including cosmetics and pharmaceuticals and feed. Often the cost for the use of marble by-products with potential application in road construction projects and building construction is sometimes nonperforming because most quarries are usually away from consumption centers making their exploitation unprofitable due to the transportation cost.

Moreover, marble powder may be used as filler in the production of various types of paper, paint, plastics, rubber, pharmaceuticals, adhesives and waterproof materials, carpet, cables, concrete and coating materials. Also, fillers may be used as blast furnace flux and neutralizer for industrial waste acids and heavy metals sorption. (Pincomb & Shapiro, 1994; Kaliampakos & Bourgos, 1998; Technical Chamber of Greece, 2004; Marras et al., 2010)

Fillers are characterized the relatively aggregates added during the production of a product influencing its final composition. Fillers serve a functional role, varying from reducing the cost of the finished product to improving its quality. (Panagopoulos et al., 1991) In the industrial market, the largest and best-known group of fillers is carbonates fillers. The carbonate fillers depending on the source, crystal structure and their composition can be: limestone, dolomite, marble powder and various chemically preset filler products (Technical Chamber of Greece, 2004).

The market of fillers provides significant gains and the increasing global demand occurs mainly due to their many applications. The introduction of fillers on the market requires proper promotion, except from maintaining their natural and acquired properties.

Some properties of Greek marbles offer significant advantages for utilizing their by-products. For instance, the use of marble powder from Dionysus marble, for plasters provide significant resistance to weathering and its whiteness is often preferred for decorative purposes (Dionysso Marble). Moreover, the use of by-products from marble quarried in Thassos is preferred as (Kaliampakos & Panagopoulos, 1995):

- raw material in the flat glass industry with main advantage the high MgO content in parallel with the low content in color blends

- filler color, observing the prerequisite standards and being highly competitive due to the brightness (97% content of MgO, one of the highest among the mineral fillers)
- plastic filler, a research about its use in flexible PVC, presented improved mechanical strength and increased hardness as well as dissolution resistance
- decorative and abrasive material and for uses with low prices but increasing demand, such as in metallurgy and refractories.

Greek market does not absorb significant quantities of dolomite products mainly due to low development of industrial sectors that may utilize it. On the other hand, the international and European markets import substantial quantities of dolomite as European industrialized countries exploit it, importing of lower quality than the Greek (Kaliampakos & Panagopoulos, 1995).

Despite the fact that marble by-products are not utilized in Greece to the proper extend there are companies that trade them, such as Dionyssomarble Dionyssos-Pentelikon Commercial & Industrial Marble, Ionian Kalk S.A. Industry of Amorphous Calcium Carbonate (Talk and Dolomite), Karmpokal S.A. Mining minerals and earth goods, Microfill Fillers & Extenders K. Zafranas S.A., Omya and Imerys Transform to Perform.

## 4. THE LEGAL ASPECTS OF THE INSTALLATION AND OPERATION OF MARBLE QUARRIES AND MINING WASTE MANAGEMENT

In order to understand the legislative and administrative barriers faced by many businesses wishing to be engaged in the use of marble by-products, first the important institutional sector should be approached related to the overall sustainability and development.

The legal framework of the marble mining is mainly determined by the Law 669/77, which separates the marbles from the categories of industrial minerals and aggregates. The siting of these mining activities depends entirely on finding or not deposits. By this provision siting aggregates quarries are excluded as they are permitted only in quarry zones. According to Article 12 of the Law 2837/2000, the area in which marble deposits are located is considered by Law as sited quarry and a Preliminary Environmental Assessment and Licensing are not required, however an Environmental Impact Study (EIS) has to be filed. The largest united area that a marble quarry may be occupied sets at 100 ha, with a minimum specified 2 ha. Nevertheless, there is the possibility of exceptional siting in area less than 2ha (Article 4, paragraph 3 of 669/77 Law). According to the Annex V of the Ministerial Decision (MD) 1958/12 mining marble is integrated in project categories A1 or A2, depending on the area and the protection regime of the region. Surface and processing facilities of products, that possibly accompanying quarrying, are considered to be included in the overall project.

The operation of marble mining businesses outside predefined zones creates flexibility that meets the reasonable prerequisite detection of the deposit. On the other hand, this situation contributes to the insecurity of the marble mining sector, as relocation is frequently required in case of land use changing, such as expansion of urban projects. According to A. Bralio (President of the Federation of Marble Unions in Greece) the state should decide the determined components for the siting of these mining activities, ensuring that businesses are not "persecuted" years after having received legal licenses (Bralios, 2009). In the Law Draft that has been filed in 2006 "Research and exploitation of quarries and other provisions", had been proposed the siting of marble mining areas, which, however, is not viewed favorably as it contradicts with entrenched socio-economic perceptions, lack of confidence in the administration mechanism, as well as to existing activities in each area. Particularly, Article 4, paragraph 1 of the Law Draft stipulated that: “In areas of the country, where the quarries of industrial minerals or marble are highly developed and its operation is essential to the national economy, in view of the extent and quality of the deposits, it is possible for these areas to be defined as specific zones by a Presidential Decree, where the right to operate such quarries is exercised as a priority according to paragraph 3 of this Article”. It is worth mentioned that the Law Draft concerning quarrying and mining activity, has been discussed many times and repeated attempts for editing and modification have been made, yet still has not been voted with the last motion made in 2014, and did not proceed to completion in legislative text. If this provision had been voted the concentration of similar businesses, organization and coordination of mining would be feasible, as well as the effective restoration of quarries in a uniform manner. This would accommodate the creation of local economies

and the retention of rural population (Tzeferis, 2007). A survey conducted in Greece for external cost and the phenomenon “Not In My Back Yard” (NIMBY) concluded that despite the fact that the marble mining has less impact on the human and natural environment than other mining holdings, however, residents of local communities often express strong opposition to the quarries establishment. Specifically, residents, of four communities of Southeast Attica, participated in the survey recognized environmental degradation at a rate of 32% (referring particularly to landscape alternation and dust dispersion). However, the majority agreed that despite the environmental impact, these activities contribute to job creation (91%) and economic development (78%). For these reasons, and because of the recognition of the timeless and nationwide value product, a large proportion (66.2%) voted in favor of the continuation of marble mining. This research presented that compensation to the communities from the companies may have a positive influence on the perception of the people about the installation of quarries (53% stated that accepts as a redeeming measure compensation and 20% that refuses it completely) (Pelekasi et al, 2012).

Admittedly, the existence of several marble quarries scattered in the Greek territory, often small, in inaccessible areas, does not help the sustainability of farms and the cooperation between enterprises of the industry sector. Simultaneously, the usage of by-products is unprofitable, as there is no proximity to the market centers. However, the Ministry of Productive Reorganization of Environment and Energy cooperating with Environment and Sustainable Development Operational Program, are working towards mapping the activity and organization of space for better exploitation of mineral deposits, trying at the same time to draw the Special Spatial Plan for the mineral wealth (Maniatis, 2014).

The Joint Ministerial Decision (JMD) 39624/2209/E103/2009 “Measures, conditions and restrictions about the management of waste from extractive industries, in compliance with the provisions of Directive 2006/21/ EC” states that: “extractive waste is waste arising from the exploration, extraction, processing and storage of mineral resources and the operation of quarries” and abandonment, illegal unloading or uncontrolled redeposit are prohibited. Further, Article 11 of JMD 50910/2727/03 "Measures and Management Terms of Solid Waste" anticipated that any holder of waste must either deliver waste to management entity or to approved alternative waste management systems, or to ensure himself recovery or disposal. Moreover, Articles 14 and 24 of 4042/12 Law establish clearly that the responsibility lies on the producers themselves or holders of waste. Also, Article 25 of the above law states the principle of the extended producer responsibility, which provides that people, who professionally treat, process, sell or import products, have the responsibility of the producer. The priority is to recover the products and subsequently recycle them. In Article 11 paragraph B. v. 1.2 of JMD 39624/2209/E103/2009 is determined that in the case of the Composite Waste Operator (when the operator of the mineral is the waste management as well) the EIS is necessary to provide both the actual activity of mining, and the installation management of mining waste as a complementary project. The environmental conditions approving decision issues uniform for the whole project.

The mine waste management organization is required to prepare a Waste Management Plan (Article 5 of JMD 39624/2209/E103/2009). The main objectives of the management plan should be the following: 1. Prevention or reduction of waste production and its harmful effects, 2. Promoting the recovery of extractive waste through recycling, reuse or recovery and, 3. Ensuring safe short and long-term disposal. Combining all of these provisions it is concluded that the operator is responsible for the waste produced and has to adhere to the principles of prevention - reduction / reuse - recovery / safe disposal. Finally, it should be noted that an Ordinary Waste Operator about the management of waste aggregates, videlicet a management organization that is not the operator of mineral resource at the same time, has not been created yet.

The MD 12050/2223/11 approved the Mining and Quarrying Works Regulation which determines that the management of mining waste should be implemented in a way that: a) human health is not endanger, b) methods that can harm the environment are avoided, c) nuisance through noise or odors is not caused, or adversely affecting the countryside or places of special interest. Similarly, companies should provide the possibility of using by-products that come from the production process. If the utilization of by-products is not economically feasible, then these should be removed and disposed of in a safe way. The implementation of Best Available Techniques (BAT) is proposed during the research and mining, as well as the deposition-waste management.

Utilization marble right extents both to by-products and waste (the Article 19 of Law 669/77) Further, according to the paragraph A of Article 3 of Law 4262/14, aggregates extracted as by-products during the mining of industrial minerals and marbles, are, freely purchasable from the exploiter, who is required to pay a special fee to Local Authorities and the proportional rent to owner of the area. The prerequisite to sale the aggregates is to have been removed the amount required to restore the site, which is accurately determined in Environmental Impact Assessment. However, the last paragraph of that Article states that: *"In any case, the evidence of the technical study should be document that the exploitation of the industrial rock or marble mined is the main activity, namely that the industrial mineral or marble mined is the mineral with the highest participation rate on the value of quarry products that are sold"* (Article 3 paragraph b v. B Law 4262/14). This providence has been set as a safeguard both to prevent misuse of the provisions related to free disposal of by-products and to avoid unfair competition that may arise due to favorable «a priori» installation of marble quarries and other advantageous terms of legislation, concerning the conditions for establishment and operation of aggregate quarries.

At this point it is necessary to refer briefly to the arrangements regarding marbles chipping quarries and consequently marble powder. The MD II-24/F.17.27/4229/07.04.1986, had inducted marble chippings in the category of marbles. However, the Decision numbered 1682/2000 of the Council of State considered that these minerals do not meet the legal requirements for designation as marbles and that fall into the category of aggregates for special purposes (Tzeferis, 2014). Since then their mining permit is in accordance with the provisions of aggregate quarries, although even their institutional operating framework has not been set clearly.

According to the Article 14 of 669/77 Law, marble quarries have to complete and send annually in Mine Inspections a special questionnaire form (Activity Sheet) containing techno-economic data of the previous years, representative to the activity of the firm (Papadopoulos, 2002). However, companies are not required to report data indicative to the viability of the operation, because of not updating the relevant provisions, as well as because have not been defined yet the appropriate indicators. These indicators may assess waste management, energy conservation and water management, environmental management, rational land use, employment, health and safety of staff and development of the local community. These categories reported for the years 2007- 2011 as "Sustainable Indicators of Greek quarrying and mining activities" (Tzeferis et al, 2013) and summed with quantitative criteria for all the enterprises of the Association of Mining Industries. This effort triggers planning and institutional providence of implementing the appropriate indicators that are applicable both to large and small businesses. It is obvious that the assessment of the appropriate indicators is crucial for the analyzed record of present situation, control and activation of the investment mechanisms. In addition, is mentioned that the electronic registration system of Waste Producers Annual Reports has not been completed yet, although is provided by Law 4042/2012 for all kinds of waste.

The data of marble quarries operations are not encouraging regarding to the disposal and recovery of mining waste. The licensed areas are not sufficient to place the extracted volume of minerals resulting, in most cases, to dispose waste at off-license areas or be transported, unnecessarily, from point to point depending on the course of quarrying. A proposed solution is to grant more extensive licenses, including the fields of quarrying, exploitation and deposition. In this way it is intended: a. the creation of spatial conditions for the establishment of integrated business, b. the direct and practical assumption of responsibility of the exploiter's waste, as noted, inter alia, the disposal of by-products in public woodlands, resulting them be declared necessarily reforested, issuing administrative eviction protocols and ultimately not reverting to the previous state. Other cases involve the destruction of important geological formations and geotopes. The Law Draft "Research and exploitation of quarries and other provisions", which was filed in 2006 combining the Articles 9 paragraphs 2 and 8 Annex 4 B, proposed the single farm for marble quarries to extend from 10ha that are up to date, to 25 ha.

## 5. INDUSTRIAL SYMBIOSIS PROPOSAL

The appropriate utilization of marble by-products is necessary, as they consist the largest amount of extractive raw material and can be treated as products instead of being heaps of unused sterile that hamper the mining and contribute to environmental degradation. In the way of integrated

management of mining waste and therefore the use of marble by-products, some approaches in the context of Industrial Symbiosis, are proposed, since the necessary conditions for the by–products disposal are created. The vision of Industrial Symbiosis is to save water, energy, materials and the distribution of services for the protection of environment with simultaneous exchange of expertise between the companies involved (E-symbiosis, 2015). According to Mr. Petti, an expert in industrial networks and symbiotic procedures, "The Industrial Symbiosis refers to a systemic approach to a more sustainable and integrated industrial system, which identifies opportunities for the exploitation of non-adequately used resources" (Ecomark, 2012). Industrial Symbiosis is consistent with the environmental principle of precaution and preventive action and the means or tools that can be used to achieve this, should lead to an industrial viability, which not only premise environmental sustainability, but simultaneously is a challenge for the optimal companies' development in an economic and business level (Papathanasoglou et al, 2014). Furthermore, for the successful implementation of a similar framework adequate economic incentives should be present, in order a balance between business income and environmental costs of new technologies and statutory restrictions to be created (Gersternfeld, 1999).

Industrial Symbiosis is encouraged by European Resource Efficiency Platform (EREP), considering it as one of the basic strategies to double resource productivity by 2030. The networks of Industrial Symbiosis, where they have been applied, have been proved successful, both in terms of prevention of waste and in terms of saving natural resources, promoting in a parallel manner innovation and creating environmentally friendly jobs. Recently the National Strategic Plan for waste prevention has been approved, suggesting Industrial Symbiosis as the best solution for industrial waste management issues, since through an organized system, waste of one industry can be useful raw material for another (Ministry of Environment, 2014).

Based on the above strategic approaches, the creation of institutional capabilities and motivation to the companies are imperative, so as the marble by-products won't be disposed as waste. It is true that the most modernized quarrying sites depend on more and more consumption of energy and water, while on the other hand they are tested by the difficult issues of rational deposition of their mining waste. Also, according to the EU Regulation 1907/2006 -REACH, quarrying enterprises are encouraged to use ecological and sustainable materials so as to be improved on recycling and avoid the use of hazardous chemicals (Tzeferis et al, 2013). The waste of material and energy would be significantly reduced, assuming that the model of Industrial Symbiosis can operate through a network of cooperating companies that operate in a particular spatial entity. At the same time, the sector will be strengthened by the attraction of new buyers in the market and the creation of new jobs.

Specific components are required in order to achieve the implementation of Industrial Symbiosis model. One of these is the creation of functional systems in a specific location, so as maximum energy saving and the reduction of operating transport costs could be possible at the same time. The geographical coherence of activities requires specific spatial choices in response to different conditions of each area (type of exported marble, socioeconomic data, number and capacity of enterprises, innovative activities, etc.). Specifically, for the design of marketing, the available markets, their distance from them and the comparative advantages for optimum propulsion, must be taken into account. Namely, each space has different capabilities and needs, which should form the basis for every spatial and business planning. Another component is the investigation and reporting of possible uses of products, based on the properties of extracted marble, research project which could be carried out within a national range program. Clearly, at an era that state's financial aid is minimal, the use of financial tools, such as those available through the European Innovation Partnership on Raw Materials (EIP on Raw Materials), is required in order the necessary business risks are undertaken.

The issues for the implementation of Industrial Symbiosis are numerous and refer to a set of economic, social and technological parameters, which sometimes concern the entire industry (e.g. electricity cost) and others refer to specific sectors (e.g. imports' and exports' tax approach). In our country there is lack of comprehensive institutional approach to achieve Industrial Symbiosis, which is reflected in the whole range of businesses, including mining. Nevertheless, the introduction of this concept is optimistic in the National Strategic Plan for Waste Prevention, since a coordination of capabilities and cooperation at national level is proposed, either through the establishment of a specialized entity, or a national program of Industrial Symbiosis. However, the legislative framework just actualizes the political decisions regarding the regulation of development options. In conclusion,

the state's support to the sector and the solution of multifaceted problems are prerequisites, so as the incentives for the rational use of marble by-products to be provided.

## 6. CONCLUSION

The natural resources' exploitation has been considered an issue of public interest, due to the major economic and social needs Greece has nowadays. In several occasions, the case law has evinced that the environmental protection and the economic development are indissolubly connected and not contradictory. That occurs when the damage in the environmental good is limited and reversible and there is no conflict between the articles 24 and 106 of the Greek Constitution (Stoubidi, 2010). Nevertheless, such an activity is truly of public benefit when is implemented with the minimum environmental footprint, utilizing the maximum of the natural resources extracted.

The technological capabilities of the marble by-products exploitation are great, but due to several reasons, no adequate research, business initiative and state action or intervention has been made. Cohesive policy is required, taking into consideration the local characteristics and dynamic of each area of interest. Whether considered cumulatively or alternatively, the main propositions that could lead in a positive reaction are:

- ✓ Modification of the legislative framework that concerns the quarrying and mining activity, with the adoption of integrated approaches that correspond to the principles of sustainable development.
- ✓ Establishing annual compulsory update from the enterprises, concerning the type of mining waste and their disposal route.
- ✓ Siting marble mining areas, targeting to a quarry registry, the elaboration inside these zones and their connection with the rest of the business networks.
- ✓ Extending the quarry boundaries which will also act as a solution to the mining waste issue.
- ✓ Accelerating the license procedure and reinforcement of the state supervision, after staffing the relevant departments.
- ✓ Drafting a nationwide program concerning the capabilities of utilizing the marble by-products, depending on its composition and attraction of possibly interested companies
- ✓ Rational design of business networks within the Industrial Symbiosis model for the appropriate utilization of the marble by-products. These networks should take geomorphology, the distance between the operations and the zones of commerce seriously into consideration.
- ✓ Exploiting domestic ores when carrying public or municipal works out, getting the raw material from nearby quarries, reducing the construction of borrow pits at the same time.
- ✓ Reevaluating the tax frame of imports and exports.
- ✓ Utilizing the investment programs.
- ✓ Communication between the institutions and state services, in order to have a common ground of action.

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