# The Reasons for the Implementation of the Concept of Green Port in Sea Ports of China

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Increasingly, China is showing endeavours to understand the idea of sustainable development. This is evident in the policy of Chinese ports development, which assumes efforts to assign it, or at least to adapt it to conditions of the sustainable development. However, from the three optic of the sustainable development i.e. economic, social and environmental, the latter is the most visible in provisions of the policy assumptions of Chinese seaports. The purpose of this article is to point out the reasons of implementing environmental principles of the Chinese ports sustainable development. The relationship between the concept of sustainable development of the port and the green port has been characterized. The areas of a negative impact of the port on the environment are identified and described. Based on cases of Chinese ports, the key reasons why the concept green port is being implemented have been highlighted.

**Keywords:** sustainable development, sustainable transport, green port, sustainable port development.

## 1. INTRODUCTION

Sustainable development and environmental protection are nowadays among the greatest challenges faced by our society and economy. For maritime ports and related activities environmental issues are becoming a competitive factor. The concept of sustainable port development includes three main perspectives: 1) an economic perspective including returns on investment, efficiency of the use of the port area, and provision of facilities for companies to maximize their performance; 2) a social scope such as the direct contribution to employment in port companies and activities connecting to the port; 3) an environmental performance and management including noise, pollution, air quality, dredging operations, and dredging disposal [15];[16];[17].

More and more studies are being published in the literature on the implementation of sustainable development assumptions for the activities of seaports [18]; [21]. In particular, the areas are identified, and the level of a negative impact of the port and its activity on the environment is analysed [19];[23] as well as on the living conditions of the population in the vicinity of the port [24];[25]. The determinants and attributes of the green port concept [20];[22] are defined.

The green port concept is narrower than the concept of sustainable development. It is one of the three earlier indicated optics of an impact. If we talk about the sustainable port development, referring to the definition of sustainable development in the Brundtland Report [26], it means a port development which meets the needs of present generation and at the same time respects needs of generations in the future. Some of these assumptions are partly met by the Green Port concept, creating conditions for efficiency of resources, low emission of dusts and other harmful substances, low emission of noise and a rational economy of land use. According to Pavlic et al., the green port is defined as a product of the long-term strategy for the sustainable and climate friendly development of port's infrastructure. In summary, the idea of sustainable port development in relation to the green port concept is of practical character.

## 2. AREAS OF NEGATIVE IMPACT OF THE PORT ON THE ENVIRONMENT

Ports should be considered as elements of nodal logistic infrastructure (partly linear – access roads), combining economic functioning at the junction of land, sea and air environment. Assuming such an area division, it is possible to set down a cross-configuration relationship of influence in functioning of ports and to refer to possible sources of the negative impact of ports on the environment. The area division mentioned above is shaped by the sources of influence derived from (Table 1):

- Port infrastructure,
- Vessels and technical means of internal transport (suprastructure),
- Technology means of operation and handling (in the range of goods and material trading),
- Technical social facilities (in terms of human functioning in port and also passenger service),
- Communication and transmission technologies (pipelines and Information Technology services).

seen the aspect of emitting hazards, but also the aspect of preventing and finally eliminating the effects (including the ability of restoring the environment). The environmental balance should be the resultant of actions in all these areas. So, if it is assumed as a starting point to create integrated environmental ecology solutions in the area of port activity, then as pro-ecological can be recognized these activities which lead to sustainable port economy and its impact on the environment.

## 3. ASSUMPTIONS OF THE GREEN PORT CONCEPT

The aim of the green port concept is the rational use of resources, pro-ecological conducting of investments, ecological orientation of technology and changes in the institutional behaviour of the port [9]. The result is the ability of effective and efficient responding by the port to the needs of stakeholders without exposing the environment for destruction. The concept of „Green Port" is supported then on several basic assumptions, described in Table 2.

Table 1. Characteristic of port areas impact on the environment.

| Source | Characteristic of the environment | | |
|---|---|---|---|
| | Land environment | Marine environment | Air |
| **Port infrastructure** | Pollution by solid waste from refurbishment, modernization and infrastructure works. | Transport (transfer) of gaseous and liquid hazardous substances. | Greenhouse gases emission due to the energy consumption. |
| **Supra-structure** | Emission of heavy metals resulting from the combustion of low quality fuels in old generation engines. Destruction of grounds - wharfs. | Wastes and municipal wastes of ships (in the case of passenger ships), leaks. Contamination resulting from loading, unloading and handling. Biological contamination. | Emission of exhaust fumes from using of low quality fuels. Greenhouse gases and volatile chemicals. |
| **Technical and technological means** | Industrial waste resulting from the production of oil and its consumption. Heavy metals entering the groundwater. | Generating so-called port waste. Contamination resulting from port operations – suspended, biochemical and chemical contamination. | Gases and chemical and biochemical dust. |
| **Technical social facilities** | Solid wastes and chemical liquids resulting from the modernization and deliberate adjustment. Unmanaged municipal waste. | Leaks of refrigerant fluids. Transmission of greenhouse gases resulting from human activities. | Emission of $CO_2$, NOx, PM10 and PM2,5 due to electricity consumption, heating (cooling) |
| **Transmission technologies** | Penetration into the soil of chemical spills of petroleum derivatives. | The chemical compounds arising as a result of heat production and lack of management of rain water and water chemical compounds, which change the biological sphere of the coastal zone. | Emission of greenhouse gases. Emission of smog due to combustion of fuels. |

Source: Own study based on: [3]; [4]; [5]; [6]

The challenge for ports is the effectiveness of tools and activities reducing the negative impact of business on the environment. The diversification of pollution sources of land and marine environment, of noise and smog, creates a clear trend in activities which, in addition, should have a complex character. First of all, there should be

Table 2. Characteristic of assumptions of the "Sustainable Port" concept.

| Assumptions | Characteristic |
|---|---|
| **Actions taken to prevent and reduce air pollution.** | The majority of pollution is generated in the port by operational and handling activities (and also production), as well as investment processes and means of transport movements and the transportation of hazardous liquid and gas substances. In the first place should be reduced the emission of pollution in accordance with international regulations. This is possible by strengthening internal pollution policy of ports in using pro-ecological technologies, as well as the proper monitoring system. The port is committed to provide a pollution handling and monitoring technology and to promote pro-ecological attitudes of port users, which can be supported e.g. by financial incentives. |
| **Action to prevent and reduce sludge and soil contamination.** | Emphasis should be placed on identifying impurities causing soil damage. Soil contamination is the result of transmission operations, production, handling operations related to oil and water management (grey water). Pollution sources can also be seen in factors generated by passenger service. Prevention of the soil contamination should be understood as the effective management and monitoring to identify hazards and their source of origin. In addition to the port policy for soil protection, there should be introduced pro-ecological technologies for preventing and monitoring the degree of destruction. |
| **Effective improvement of water quality (including marine coastal ecosystem).** | The main source of water pollution and a destruction of the aquatic ecosystem is the movement of ships within the port, waste from ships, leakages and the internal port infrastructure. It is obligatory to develop an effective system for management of grey water outflows, production and pro-investment wastes. The priority is also to service ships in terms of technology of the industrial and municipal waste reception. The policy of an effective water ecosystem should also be based on the effective and rapid fighting and eliminating the effects of leaks to the surface of water. |
| **Limiting the impact of port activity on aquatic and land ecosystem in terms of living fauna and flora.** | „Green port" should be a motto meaning care of flora and fauna present in the natural environment of the port. Ports should monitor the state of habitats of animals and plants. In this regard, ports should also plan conservator's activities to allow restoring animal and plant habitats. To the elimination should be subjected such factors as excessive noise, heavy metals, excessive exposure to artificial light. The priority is to strengthen the natural aquatic and land-air ecosystem. |
| **Effective technology to limit energy consumption in the port / using renewable energy sources** | The policy of reducing energy consumption should be a priority. Energy efficiency should be close to ecological requirements. In addition to limiting the use of port handling equipment using electricity, a large source of the energy consumption are social facilities – including office activities (there also heating and cooling). Attention should be paid to the possibilities of using renewable energy sources or to increased degree of their use. |
| **Real reduction of noiseand vibration** | The port work, traffic of vehicles and ships are cumulated source of noiseand vibration. The noise is generated at the port area and in the radius to areas near the port. In addition to the research and monitoring of the noise generated by the port, there should be considered as strategic the activities preventing the spread of noise. For this purpose it is possible to use, among others: the reduction of noise source of the machine (replacing them for less noisy), sound absorbing shields, the reduction of busiest areas in the port as well as transferring the equipment and transport means on so called idle-speed. |
| **Monitoring and analysis of weather changes affecting the functioning of the port and ecosystem of the environment.** | The issue of monitoring the status and weather changes is also important. The port operation is affected by temperature, air humidity and wind intensity. The effects of pollution in terms of weather changes include visibility, slippery surfaces and excessive rains. Weather changes also affect the level and number of accidents (including disasters in the port). Monitoring and weather assessment policy is a priority in determining performance and work tempo of the port. |
| **Research and development. Expanding green growth prospects for the port.** | By identifying threats being the result of port activities, it is possible to make the research analysis and to look for eco-innovation solutions. Estimating the external costs of changes occurring in the natural environment through the port activity can be a basis for finding comprehensive solutions to prevent destruction and can also serve to forecast and model the long-term effects of taken actions. This enables to control them effectively. |

Source: Own study based on: [10]; [11]; [12].

Basically, the implementation of green port concept is possible in every port in the world. Possible differences (including problems) arise primarily from the geographical location, the degree of technology development and industrialization, and also the state of progress of the pro-ecological internal regulations in the countries where operate the ports.

## 4. PREMISES TO INTRODUCE THE STRATEGY OF GREEN PORTS IN CHINA

### *4.1. SOCIAL PREMISES*

Chinese nationals who live in the vicinity of ports are directly exposed to risks related to the emission of pollution from port activities. The increasing mortality among people and increasing number of respiratory and cardiovascular diseases are directly associated with the emission of such compounds as $SO_2$, NOx and particles PM10 and PM2.5. Compounds like $SO_2$ cause respiratory and

cardiovascular diseases but also have a significant impact on the mortality of population. The destructive influence of NOx (nitro-oxygen) on respiratory irritation was also noticed, and it was recognized as a reason of long-term disturbances in the development of children. Pulmonary deterioration, increased risk of cancer and chronic diseases which increase mortality, are due to particles PM10 and PM2.5 [13]. Only in the region of Pearl River basin, the air polluted by the above mentioned compounds is the reason of over 11 million ambulatory visits. In the same region, for the same reasons, there were recorded about 440 [2]; [6]; [14] thousand so called hospital-bed-days per year. Only on the scale of one region it is involved with costs, (costs as the result of pollution) of about 22 million euros per year [12]. Not only the quality of the air, but also the quality of waters and the condition of land environment contributes to the decision of starting and carrying out an analysis of the port activities impact on the environment and the quality of human life.

*4.2. ECONOMIC PREMISES*

Over the past 10 years, China estimates spending amount for the disposal of pollution effects to be about 175 billion Euros, although the pro-ecological spending represents a small percentage of these costs. The vast majority of this amount includes costs of air and soil cleaning and costs of medical treatment of the people, compensation and indemnities for lost health and costs of insurance. The increase of pollution costs is growing faster than the gross domestic product. The growth of GDP amounts to about 10% comparing to 14% increase of pollution. From the economic point of view, the Chinese economy geared towards the promotion of economic growth, effectively ignores an obligation to run the policy of pollution elimination and above all its prevention. Even with the assumption of limited greenhouse gases emission, increased degree of using renewable energy sources, the reduction of pollution costs in 2015 was only by few percent. However, from the point of view of the economic development and the incorporation of the national pro-ecological policy to the global activities, China is placed in the position of the country seeking to change quickly the present state of environmental destruction [14].

*4.3. ECOLOGICAL PREMISES*

In recent years the Chinese government has intensified its pro-ecological activities. The point of reference was to achieve till 2015 the reduction of pollution by about 8-10%. The so-called five-year plan assumed that till the end 2015 the guidelines would be introduced and enforced to reduce emissions of carbon dioxide, ammonium nitrogen and nitric oxide [14]. The assumptions of the above plan were expected to reduce the emission of $SO_2$ and ChZT by 8%, and also to reduce the emission of nitrogen and ammonia nitric oxide NOx by 10%. In addition, they assumed that there will be achieved a reduction of $CO_2$ emission per unit of the gross domestic product by 7% (the reduction of $CO_2$ is measured in relation to GDP growth). For the past 40 years, the above mentioned factors have contributed in areas around the port to the formation of smog which systematically reduces visibility by about 0.3km every year. For reference, it should be noted that the average visibility, (the visibility distance) was 5,4km in 2008, and only about 3.7km in 2014. The fog, defined as an atmospheric thickening through dust, smoke, fumes resulting from the mixing of solid and liquid particles in the atmosphere, is a result of not only port activities but also industrial and non-industrial activity of the people. In this respect, the contamination results mainly from anthropogenic sources. In addition, the fog (smog), in locations of regions around the port, is formed by the so-called dust. In 2011, the average dust fall was recorded at the level of 4.62 ton / $km^2$ per month. Over the years 2010-2012, despite the recorded decrease in the fall of dust, the monthly average fluctuated still at the level of about 3.25 to 5.97 ton / $km^2$. In addition to the above contaminations, it is pointed also to the handling of hazardous materials in the port. These materials are toxic, inflammable, explosive or otherwise hazardous to human health and the environment. Hence, it is important to reduce the risk of contact with these materials.

*4.4. TECHNOLOGICAL PREMISES*

China is experiencing an economic slowdown. However, at the contact point related to the place occupied by the Chinese economy, and the place it occupies in the global supply chain, attention should be paid to the continuous growth of industrialization and the increasing capacity of Chinese ports. The role of this chain link in the economy is to ensure the proper handling of

industrial sectors for which Chinese ports are not only the stop on the way, but mostly are the last stage of transport. Chinese ports provide logistic service to such industries as automotive, petrochemical, biopharmaceutical, machine and manufacturing industries, shipbuilding, electronics and IT. In order to ensure proper, efficient and effective service, ports are forced to use technological solutions integrated with world technology. For this reason, it is necessary to ensure the compatibility of the applied handling and IT technologies. This development is leading to the increased performance of the port in logistic service of the above mentioned industries, but also enforces using technologies by the port, that may be already a part of pro-ecological activities.

### *4.5. PREMISES OF DEVELOPMENT*

Among the development premises, should be indicated these, which generate the increase of importance of Chinese ports in the economy of China but also in the world economy. Development premises are a peculiar combination of ecological and technological conditions and resulting from the place of Chinese ports in the global chain of supplies. A priority for Chinese ports is today to be included in the global ecological trends related to applying logistic and transport infrastructure and suprastructure. The gradual increase of capacity of Chinese ports requires not only using modern and pro-ecological technologies and practices, but also enforces ports to look globally on the ecology of the whole world. The exclusion of Chinese ports by failing to adapt to ecological and eco-innovative trends in the world can directly affect the risk of slowing down the regional economic growth. Therefore, there is a risk of excluding or omitting Chinese ports in the global supply chain.

The large industrialization of Chinese ports and their capacity, however, requires intensifying the pro-ecological activities in the direction of ecological chains of supply. The development in the age of globalization is not possible without entering into the global ecological trends. Linking technology and ecological attitudes and reducing an impact on the environmental degradation is a condition for further development of Chinese ports.

### *4.6. PREMISES OF THE GLOBAL SUPPLY CHAIN*

China, due to its geographical location, has ports of major importance in the organization of global supply chain. It has a number of international connections in the transport and handling of cargo and containers. Shipping routes to which Chinese ports are connected have about 100 destinations. It should be recognized that Chinese ports are not only an important link in the international chain, but are of high importance in the domestic trade. Shipping routes include Singapore, Indonesia, Japan, South Korea and also Australia and Africa. The connections, equally important are with European ports, among others: Rotterdam, Antwerp and Hamburg. As compared to other world ports, the most activities of Chinese ports are not sustainable. The reason, why the world does not notice the sustainable activities in Chinese ports, is attributed to the excessive air pollution, the degree of energy consumption and negative impact on climate changes. There are two main reasons of this perception. First, excessive pollution (keeping unclean) of transport means i.e. – trucks, barges, sea vessels and cargo terminals (including harbour production), which contribute to high emission per tonne per kilometre. Second, in the multimodal transport dominates the road transport (of high emission) - it is estimated that 85% [20] of the carriage (supplies) of containers in Chinese ports is done by the road transport. Chinese ports face the challenges of global supply chains. The tendencies of global supply chains are geared towards transforming the degree of participation of the particular transport sections in transporting cargo. Strong emphasis is placed on relieving the branches most harmful to the environment – namely the road transport – to those branches, which can not only transport more at one time (but often slower), but have significantly less destructive impact on the environment – i.e. rail and river transport.

## 5. SUMMARY AND DISCUSSION

Due to considerations covered by this article, the following synthesized conclusions should be formulated:

- Sustainable development trends are common across the whole global supply chain,
- There is a close dependence between the economic development of ports and the economic growth of the region in which the port operates,

- The expansion and reconstruction of ports should take into account the possibility of implementing the principles of sustainable development, including the green port concept,
- There is a number of premises which determine converting ports into green ports,
- Ports have the greatest responsibility for the creation of eco-chains,
- Eco-ports are the key element in using the transport sector with the least negative impact on the environment,
- By creating eco-ports, there is a significant reduction in mortality of local population,
- Due to sustainable ports, the objectives and goals of global environmental policy and the principle of sustainable development are executed,
- A sustainable port is the one where there is a rational use of natural resources of the environment,
- A green port uses systems and technologies preventing the environmental pollution and enabling to eliminate the negative impact of port activities on the environment.

Such formulated conclusions lead also to further questions for subsequent discussion. Firstly, can the boundaries of the sustainable development be given, or if following the global trends of continuous development is there no possibility to indicate a point (situation, measuring result), which will unambiguously determine when a port and its activity is sustainable? Secondly, it is important to try to answer the question as to how far the interaction between activities consistent with the sustainable development, and the environment beyond the functioning area of a port should go.

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