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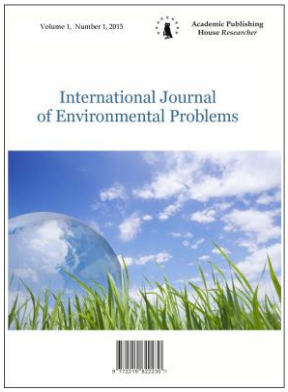

Articles and Statements

Environmental Policy in a Changing World

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Abstract

This article focuses on the question of how the effectiveness of environmental preservation policy can be increased in order to turn to a more sustainable way of human development. The answer was found to lie in the three-fold approach covering normative, economic and political measures. The normative measure is the provision of a proper environmental education, which should help creating a global public concern with the intactness of the natural environment. The economic measure refers to the linkage between the goals of environmental preservation and the goals of the economy as to remove the contradiction between the two domains of human activity. The political measure is the regionalization of environmental policy with a gradual transfer of environmental political functions from the national towards the supranational level of a civilizational bloc. This measure would allow to combine the effective implementation of the state-level with the advantage to cover a greater territory and to reduce the number of global environmental actors.

Keywords: environmental policy, sustainable development, regionalism, civilizations, supranational policy level.

1. Introduction

In its constant evolution, mankind has undergone different forms of societal organization depending on the respective modes of production each echoing the corresponding levels of technological development. Today, technology has interconnected the planet in a network of communication and transportation making societies interdependent through mainly economic mechanisms and 'shrinking' the world through the so-called 'time-space compression' – a concept introduced by David Harvey in his "*The Condition of Postmodernity*" (Harvey, 1990) and referring to a phenomenon describing the decreasing amount of time required to travel and/or communicate from one point to another, by this 'shrinking' the space and 'accelerating' the time.

While technology was required to globalize the domains of society and the economy, the environmental domain has always been "global" and, hence, mankind has always been undeniably and obviously interlinked through the natural environment. Since the beginning of sedentary life, people have started to transform the natural environment. With the technological revolution,

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however, the role of men as a determining factor of the biosphere has significantly increased creating what V. Vernadsky referred to as the 'noosphere' – a concept describing a point in our planet's evolution when the reasoned activities of men become a determining factor in the development of its biosphere (Vernadsky, 1944).

Yet, the reasoned activities of men can be referred to as truly "reasoned" only partly, as their current general course might finally result in the destruction or heavy damage of the biosphere, thus, of life itself. This self-destructive manner of most current human interferences with the natural processes on our planet generally result out of a neglect of the importance of the notion of environmental security, which is – despite any logic – still treated as an issue of low politics.

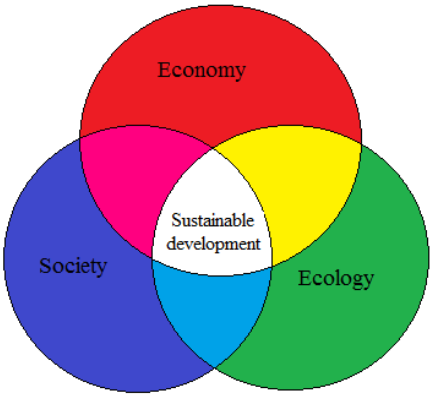
Being the zone of life on our planet, the biosphere should be regarded by mankind as its most valuable resource which is to be protected for the very sake of our survival. As argued by Andrew Hurrell "a political theory of the environment is concerned not simply with the ideas of the "good life", but also with the means to ensure human survival best" (Hurrell, 1995: 130). However, despite the undeniably great amount of requests for an upgrade of the importance of environmental safety from scientific, civil, as well as political circles, when it comes to day-to-day politics, decision makers often tend to rather focus on the immediate issues and irrationally leave out the fundamental long-term problem of how to preserve the intactness of the environment. Given the above elaborations, this article shall be dedicated to the question of what ways mankind has developed to attack the problem of environmental degradation, and whether and how those approaches can be made more effective.

2. Discussion and Results

The concept of sustainable development

The two World Wars fought in the 20th century, certainly, slowed down the general realization of the fundamental and – potentially – fatal role human beings play in the transformation of the properties of its living environment resulting out of the contradiction between the growing needs of the world community and the biosphere's inability to provide those. These topics periodically emerged on the political agenda of the different countries of the world, yet an institutionalized environmental policy can generally be regarded as a product of the 20th century. In Western Europe, for example, environmental preservation started to gain in importance since the 1970s when acid rains fell in Great Britain and environmentalists managed to successfully attract the interest of mass media (Hannigan, 1995). The environment as a policy domain became subject to international discussion and legalization at the 1972 United Nations Conference of the Human Environment (UNCHE) (Keohane et al., 1995).

Yet, the formulation of a global concept of environmental preservation took place only in 1992 when it was institutionalized in the Declaration of the UN Conference on environment and development, informally known as the 'Earth Summit'. During the Conference, virtually all states of the Earth adopted three agreements: Agenda 21 — a comprehensive programme for global action in all areas of sustainable development; The Rio Declaration on Environment and Development — a series of principles defining the rights and responsibilities of states; and The Statement of Forest Principles — a set of principles to underlie the sustainable management of forests worldwide; as well as two legally binding conventions agreed upon during the Conference: the United Nations Framework Convention on Climate Change and The Convention on Biological Diversity. The resulting global regime aimed at what became to be known as 'sustainable development' – a concept consisting of three interdependent building blocks: society, economy and ecology (Figure 1). The social domain referred to the human moral and values, their relationships and institutions. These have to be in favour of sustainable development so that it can function. The economic domain concerned the allocation and distribution of resources and capital in such a way as to make sustainable development possible. The third pillar was ecology and involved the contribution of both the economic and the social domains to the preservation of the environment (Baker, 2006: 7).



Source: based on Baker, 2006: 10

Fig. 1. Sustainable development: linking economy, ecology and society

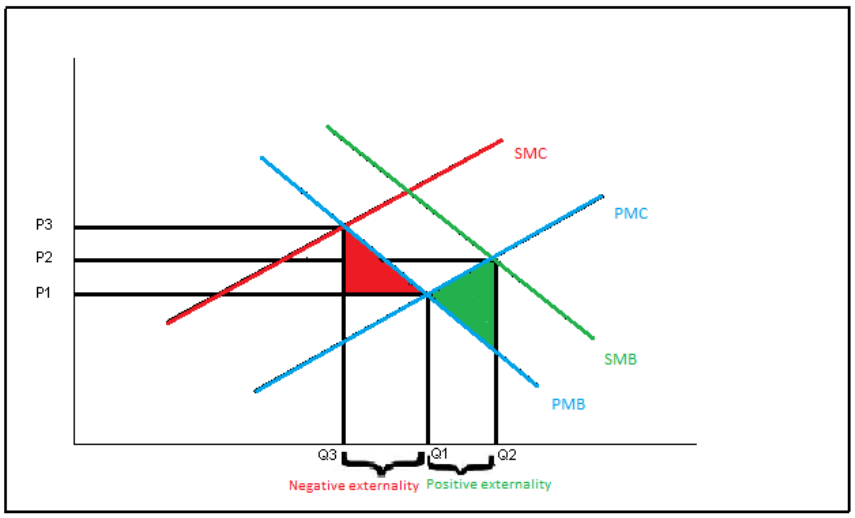
When talking about the preservation of the environment, the main emphasis lies on the attempt to ensure – excluding unpredictable large-scale natural catastrophes – that unlimited natural resources, such as sunlight, air or water, remain unlimited, and on the using of limited natural resources in a way that would provide that those resources remain available for future generations. For clarification it is important to note that limited resources are additionally divided into renewable and non-renewable ones. Renewable resources can be created or re-create themselves after a certain period of time. An example for this category would be mineral resources. Non-renewable resources are, for example, soils or animals – they cannot be renewed or re-created once they are gone.

In most cases, the major obstacle towards sustainable development is a conflict between economic and environmental considerations, whereby in most cases the former outweigh the latter. The free market economy aims at the gaining of maximal profits with the smallest input in the shortest period of time, but it does not take into consideration the environment. However, natural resources, which are necessarily used for production, have their own possibility frontiers. Once they are crossed, the productivity of these factors starts to decrease until their partly or even full destruction. A perfect example here is the degradation of soils, which can be balanced with an increase of the use of another factor of production – of capital (the use of machines, fertilizer etc.), but only up to a certain point. After this, land gets unfertile and can even become so-called 'dead land' which cannot be used for agricultural purposes. Furthermore, capital inputs also have their possibility frontiers. To make an example, phosphorites used for fertilizers belong to the non-renewable resources meaning that someday they will be gone.

Hereby, one should further accentuate that the sole investments into ecological safety may not lead to the desired goal. To make an example, in the 20 years between the UN Conferences on the Environment in Stockholm (1972) and the Earth Summit in Rio de Janeiro (1992), the global environmental situation considerably worsened, although more than 1,3 trillion US Dollar were spent on the conservation of the environment (Lukina, Lukin, 2011). In order to calculate a realistic "value" of sustainable development, conventional economic indicators such as the growth rate, the GDP or the intensity of the use of resources are not sufficient. In order to gain relevant results, these solely economic indicators should be correlated with ecological and social ones. Those are the employment rate, the costs of environmental preservation, the efficiency of resource exploitation and the use of new technologies to increase environment safety.

The conflict described above can be approached by three main instruments used in environmental policy. The first instrument is of a 'command and control'-type and "entails legislation to fix norms and environmental standards that have to be complied with. This may take the form of a prohibition of certain products or substances, or emission standards combined with requirements to use certain types of technology" (Senior, 2009: 325). The other instrument is market-based and refers to the carrying out of cost and benefit analyses and to the setting of standards, which determine whether to offer a firm a financial incentive for the compliance with the standards, or to tax the production of negative externalities. Negative externalities are emissions into the environment caused by the actions of an industry. The tax for negative

externalities is also known as the Pigovean tax and can be best described by means of a figure (Figure 2) (Senior, 2009).



Source: based on Senior, 2009: 313
Fig. 2. Negative and positive externalities

Pigou's solution lies in the 'internalization' of the negative externality through a respective tax. On the figure, where private marginal benefits (PMB) intersect the private marginal costs (PMC), there is the market optimum of demand and supply, which the regular economist pays attention to. Through the introduction of the social marginal costs (SMC) and the social marginal benefits (SMB), the identification of negative and positive externalities of a producer becomes possible. Following thereout, where the social marginal costs exceed the private marginal costs, there is oversupply of the activity causing the externality, as quantity 1 is supplied instead of quantity 3. So, there is a negative externality produced. This would mean that this industry should be taxed so that the negative externality is internalized. If, on the other hand, the social marginal benefits exceed private marginal benefits, thus, quantity 1 is supplied instead of quantity 2, there is an underproduction of the activity causing the externality, thus, a positive externality. According to this market determined instrument, in that case, the producer should get a financial incentive to internalize the positive externality.

Another instrument used in environmental politics refers to voluntary agreements between producers to reduce their emissions and to introduce more environmentally friendly technologies. Their motivation is mostly the wish to improve their image or a desired increase in competitiveness (Senior, 2009). Additionally, I would argue that a proper environmental education also constitutes an effective environmental instrument – if not a key instrument –, acting through the normative dimension and addressing the root of the problem, namely, the lack of concern with the intactness of the natural environment.

The three classical levels of environmental policy

Environmental policy is carried out on three major levels – the international, the national and the regional. However, relatively recently, a fourth "supranational" level was created. The following section deals with the advantages and disadvantages of these levels of environmental political activity.

International environmental legislation is created during multinational environmental conferences (MEAs) and can be legally binding upon the member states who are party to the respective MEA (Fauchald, 2011). The body within the United Nations (UN) responsible for the definition of international environmental norms is the Division of Environmental Law and Conventions (DELC) within the United Nations Environmental Program (UNEP) (United Nations Environmental Programme). The organ itself, though, has no power to create a piece of international environmental law. This power is only with the member states participating in an international environmental conference. There, they can decide whether or not the MEA is going to

be legally binding. In case of a binding agreement, the implementation takes place on the national level. Despite its function to set standards of international environmental laws, the DELC has to support national and regional projects through the provision of resources aimed at a strengthening of local environmental initiatives. Although the economic support might serve as an incentive for a member state and, by this, could be seen as a soft mechanism of enforcement, it is unlikely that it can be regarded as an effective means to ensure implementation due to its insignificance vis-à-vis the possible costs faced by a country during the implementation process. Thus, considering the lack of any hard power in the UN, the only layer that the UNEP has at its disposal is its normative power, which is often and, more or less, successfully used by the UNEP.

Furthermore, it is important to acknowledge that MEAs are negotiated between states, whereby the bargaining position of the state varies according to its relative power vis-à-vis the other states, as well as the current state of affairs in the international system. That means that the outcome of the negotiation might reflect, or, at least, favour the position of the most powerful state, or a group of such, who dominates the respective conference. This fact coupled with the lack of any effective enforcement instruments at the UN's disposal leads to a rather voluntary compliance by the member states. A good example to this state of affairs is the famous 'Earth Summit' that took place in Rio de Janeiro in 1992 (United Nations Declarations). During this International Conference, the today so popularly used concept of 'sustainable development' was officially introduced. Although the principles of the Earth Summit were recognized by its participants, the threshold for emissions set by the summit was too low to realistically be achieved by the world community of states. In the absence of any enforcement mechanisms available to the UN, its provisions had to be relaxed in the Johannesburg Conference in 2002, during which it was reformulated in such a way that left each member state the freedom to interpret the concept of 'sustainable development' almost freely according to its respective needs.

National environmental politics can be ranked as more successful, because national governments do have means of enforcement at their disposal. However, while theoretically available, the effectiveness of these mechanisms depends on the other two dimensions of human activity: the economy and the society. Thus, society needs to be in favour of protecting the environment, while on the dimension on the economy, environmental concerns need to be given a value and connected to the long-term goals of production. Furthermore, one should keep in mind that any action taken by a state can only affect the respective state's territory, however, nature does not limit itself to national boundaries and, hence, in order to be truly effective, environmental policy should be carried out on the planetary level. Apart from global biosphere with its general problems, single nature objects can be located on the territories of several states, which would require at least some coordination of actions between those states so that these objects can effectively be protected.

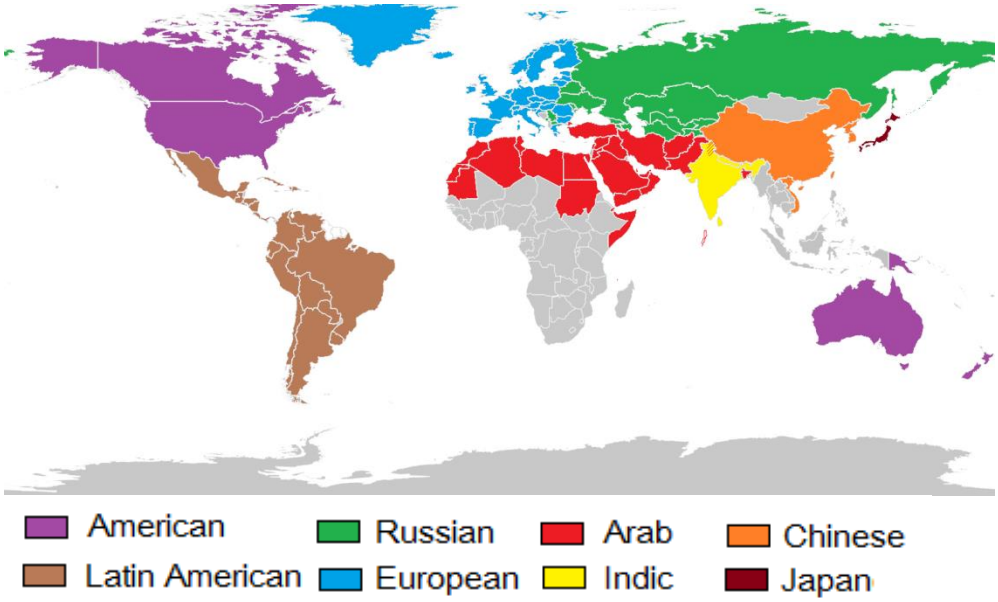
The regional level of environmental policy can mean two things: it either can refer to the local, subnational level, concerning a specific region within a country; or it can mean a region encompassing several countries, thus, be international, and concern, for example, a nature object or a territory located on the territories of several states. The local level certainly profits from the enforcement power of the state, as well as from being carried out "on the spot", which allows formulating the goals of a local environmental undertaking in the most precise way. As for global environmental issues, the local level of environmental policy – when standing alone – is rather insufficient. When, on the other hand, a regional environmental undertaking is carried out by means of bi-or multilateral agreements between states, it can easily become the "victim of sovereignty", as each state will carry out the agreement in a way it finds appropriate, and there will be no way to ensure effective implementation in accordance with the initial intentions of the agreement.

Linking global and local – the fourth level of environmental policy

Thus, the international level of environmental policy meets the needs of globality in tackling environmental issues, while lacks any hard means of enforcement, which would ensure effective implementation of a piece of international environmental law according to its intention; on the national and regional levels, effective implementation is possible in case it coincides with the state's interests, while the problem of spatial limitation does not allow to effectively protect transboundary nature objects, or counteract global degradation processes of the natural environment, such as

global warming, the loss of biodiversity and alike. The problem of how to balance the effective implementation possible at the state-level with the requirement to act transnationally, might be solved, or at least approached, on the supranational level of a 'civilizational' bloc (Gordeeva, 2016).

Indeed, when taking into account the global processes of regionalization in international relations coupled with a strong tendency of a strengthening of intra-civilizational ties, a shift in the political center from the national towards the supranational level can be prognosticated. The prototype of such a regional "bloc" was the Soviet Union; the nowadays best example of an economically and politically highly integrated regional bloc can be given on the European Union (EU). Overall, today, 7 civilizations can be separated in the international system, I would argue. These 7 civilizations are the American, the European, the Russian, the Latin American, the Arab, the Indic and the Chinese. If we consider them as "to-be blocs", we have to take into account that their current levels of economic and political integration differ from civilization to civilization. Japan can be distinguished as a separate player primarily due to its economic power (Figure 3). Some scholars further distinguish several African and even a Buddhist civilization.



Source: Gordeeva, E., 2016, p. 6
Fig. 3. Civilizations

Being currently the only politically highly integrated federative bloc among the delineated civilizations, the European Union provides the best real-life example of the supranational level of environmental policy-making. Hereby, until the Single European Act (1987), there was no common EU environmental policy, but just single directives, which legal basis was sometimes contestable (Barrington, 1993). Since then, EU environmental policy has evolved, most remarkably with the amendments made in the Treaty of Maastricht (1992), and is now an area of 'shared competences' between the EU and its Member States. That means that both the EU and the Member States can adopt legally binding acts, however, the Member States can do so only in areas from which the EU has chosen to withdraw. In areas, in which the EU has adopted a legally binding act, the Member State has to comply, and in case it does not, the European Commission may open the infringement procedure and legally enforce its decision through the European Court of Justice. In its action, however, the EU has to follow the so-called 'subsidiarity principle' meaning that the EU can take action "[...] only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States [...]" (Treaty on European Union). Despite its complexity, EU environmental policy can generally be seen as successful.

Being politically and economically less integrated than the EU, the other civilizational blocs delineated above have much less harmonized common environmental policies. To make an example, in the Russian civilizational bloc, the Commonwealth of Independent States Free Trade

Area (CISFTA) can be seen as a beginning of bloc-integration. Just as in the EU, initial integration is economy-centred and just as in the EU, it can be expected to deepen and widen its integration from mere economic to increasingly political issues and to include effective and harmonized environmental policy at some point. As for now, there is an Agreement of 2013, the so-called "Agreement on cooperation in the field of environmental protection among the member-states of the Commonwealth of Independent States". This Agreement, however, is formulated rather vaguely to be effectively followed. Apart from the agreement, there are a number of bi-and multilateral agreements of measures of environmental preservation between the CIS countries (Boklan, 2015).

In the American civilizational bloc, there is a number of bi-and multilateral environmental agreements, such as the US-Canada environmental partnership (US Environmental…) or the joint statements on environmental cooperation between the US and Australia (Australian Government); in Latin America – the Community of Latin American and Caribbean States (CELAC) has formulated a number of statements on environmental preservation (Community of Latin American…); in the Arab bloc, the League of Arab states has signed an Agreement with the UNEP to cooperate on environmental issues (United Nations Environmental), which provides a good example of how regional federative unions can ease the provision of assistance in environmental issues; in the Indic region, it is the South Asia Association for Regional Cooperation (SAARC) which provides evidence for regionalism in environmental policies (South Asia Association); in the Chinese region, the most relevant regional environmental cooperation is that between China and the Association of Southeast Asian Nations (ASEAN) (Association of Southeast…); in Africa, the UNEP supports several regional environmental undertakings, such as the African Ministerial Conference of the Environment (AMCEN) or the African Ministerial Council on Water (AMCOW) (United Nations Environmental Programme).

The supranational level of environmental policy-making certainly increases the overall effectiveness of environmental actions, as it harmonizes environmental policies among the bloc's member states, provides the monitoring necessary to control effective implementation and counteract deficiencies, be it through the provision of monetary help in case a state's economic situation does not allow it to effectively implement a law, administrative assistance, or through normative up to legal means of enforcement in case the deficiency derives from a lack of governmental concern with the issue.

Thus, in case the core state within each bloc (or a replacing body as in the case with the European Commission) defines common environmental goals for its bloc and manages to ensure effective implementation, the number of political environmental actors in the international system would significantly decrease from 193 states (official members of the UN) to 7 to 10 regions. The reduction in number of environmental actors will substantially ease the coordination and carrying out of global environmental policy. So, each civilizational bloc would define the major environmental problems within its territory, and its core state (or replacing administrative body) would approach the major obstacles towards implementation faced by the states within its sphere of influence. Then, on the global level, the identification of the main environmental issues of each region and the provision of assistance in overcoming the major obstacles a region may face in implementation will be substantially eased due to a reduction in the number of actors. So, the local and the global levels would be linked in a more efficient way as they are now, avoiding the state level and overcoming the problem of excessive complexity.

The three Pillars of Ecological Safety

In light of the preceding discussion, it can be concluded that in order to increase the effectiveness of global environmental policy and turn to a more sustainable way of development, mankind should focus on three key measures (Figure 4): 1. A proper ecological education staring from an early age needs to be provided for the global population. This normative measure will significantly improve the general understanding of our natural environment and its key role in the maintenance of life on Earth, so that people can develop a more caring attitude towards it. 2. The other measure is an economic instrument for the rise of the effectiveness of measures of environmental preservation and refers to the assignment of a calculable value to environmental preservation and its connection to the goals of an economic actor. This can be done through the introduction of a tax for the production of negative externalities (Pigovean tax) and the provision of economic incentives for the compliance with the ecological standards. 3. The final measure is

political and presupposes a gradual transfer of environmental political functions from the national towards the supranational level of a region. This measure is important insofar as it allows to combine the effective implementation of the state-level with the advantages of having harmonized environmental policies carried out on a greater territory, as well as of a reduction in number of global environmental actors.

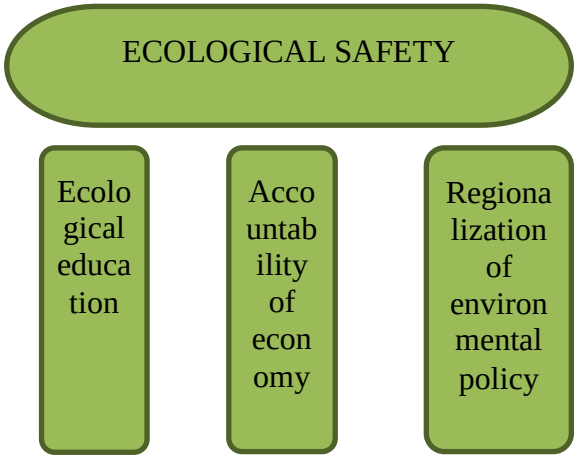


Fig. 4. The Three Pillars of Ecological Safety

3. Conclusion

This article was dedicated to the question of how the effectiveness of environmental policy can be increased. For this propose, the concept of sustainable development was shortly outlined under consideration of the conflict embedded in the men-nature system and instruments aimed at its resolution, while the different levels of environmental policy were examined with regard to their advantages and disadvantages.

The analysis has shown that the major obstacle towards a more sustainable way of human development is the incompatibility of pure economic and pure environmental goals. The solution to this problem was found to lie in the merging of societal, economic and environmental goals. In practice that means: 1. a proper environmental education, which would allow people to understand the importance of an intact biosphere; 2. the giving of a countable 'value' to environmental concerns and to connect them to the goals of production, which would inspire economic actors to increase resource-efficiency and to reduce emissions; 3. the formulation and implementation of suitable environmental legislation.

The question of how to balance the requirement of globality in environmental preservation – given at the international level – with the need of instruments of enforcement to ensure implementation – given at the state-level –, was found to be answered by the supranational political level. Considering the trend of civilization-based region building in the international system, the development of region-based environmental policy can be expected to be not long in coming. Although the only currently effective common bloc-wide environmental policy is to be found in the EU, the other civilizational regions have begun to take initial steps towards a common environmental policy. The regionalization of the domain of environmental policy is also supported by the UNEP, which actively promotes regionalism in environmental undertakings.

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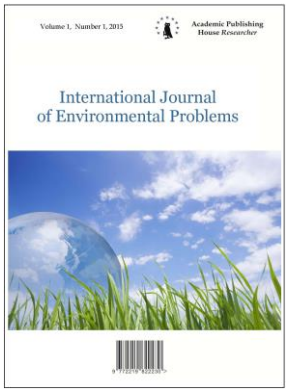

Assessing the Effects of Inter-Regional Spillover and Feedback in Indonesia

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Abstract

The development and growth of economic in Indonesia shows a positive result, but the inequality between regions and quality of environment is still a major problem. Economic activity is centered on the Java Island, while other areas in eastern Indonesia lag behind. This study focuses on estimating the impact of inter-regional spillover and feedback. The data used is inter-regional input output data in 2005, then projected to year 2011 using the RAS technique. The research is conducted in Sulawesi (consisting of North Sulawesi, Gorontalo, Central Sulawesi and Southeast Sulawesi), South Sulawesi, East Java and East Kalimantan as well as ROI (rest of Indonesia). The result shows that the region of South Sulawesi produces the greatest spillover effect to other regions. It indicates South Sulawesi region can be a bridge with other regions to improve linkages and economic performance between regions. East Java generates the smallest spillover effect compared with other regions, but it produces a greatest feedback effect. The surprising result is south Sulawesi gives a little spillover effect to other Sulawesi areas, and vice versa. It shows that both regions have a weak interaction compared to the interaction with eastern Java.

Keywords: development, assesing, feedback, inter-regional, spillover.

1. Introduction

Economic disparities between different areas become the main problems in the economy and environment of Indonesia, where the area of Java controls over 60 % of gross domestic product (GDP). On the other hand, the economic contributions Kalimantan and Sulawesi each estimated to be about 9 % and 4 %. Aritenang (2008) showed that disparities in development between regions in Indonesia are still severe, even though economic decentralization is already running. Development gaps are quite severe in parts of eastern Indonesia, except in Sulawesi (Hill et al., 2008). Indonesia western section (comprised of Java and Sumatera) plays a dominant role in Indonesian economy, contributing around 80 %, while eastern Indonesia plays a very minor role (Kuncoro, 2013). Rustiadi and Priyarsono (2010) stated that imbalances between regions are the main problem to be solved by the government, as well as effects of development on environment conditions.

Amita and Kameron (2004) have showed the biggest obstacles that led to the development and industrialization of strategic industries outside Java due to the benefits of agglomeration are quite strong in Java. Java becomes a potential market for different types of industries that drive the

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industry grow rapidly in the region. Challenges to accelerate the process of development among regions are to pay attention and understand *Indonesia's growth pole, leading sectors* in each province, *backward regions*, phenomena *debottlenecking infrastructure* and financial matters (Kuncoro, 2013).

Various studies on inequality in Indonesia less touche the spatial and economic interaction. This study emphasizes that the spatial aspects and interactions to assess the pattern of interregional linkages as a result of economic disparities between regions in Indonesia. Trade relations between the regions become a fundamental part to assess the extent of the economic impact across regions. This study aims to assess the spillover effect and the effect of feedback obtained due to the interaction of economic territory. Interdependent relationship of the various parts of the economic system is the most fundamental thing in economic analysis (Leontief, 1936). Isard (1951) say that there are two things that cause inter-regional economic relations, there are (1) because of the inequality of population distribution, income, in the broad sense of resources and (2) the existence of large-scale economic activity in certain regions. Demographic factors provide the most powerful influences on final demand (Feldman, et al., 1987). Chenery, et al (1962) reveal that changes in every industrial output in the region is caused by four things: (1) changes in the composition of domestic demand, (2) changes in the volume of exports, (3) changes in the volume of imports and (4) changes in technology and organization.

Trinh et al (2000) explain that the flow of goods between regions vary greatly affect the economic development of the region. Effect of inter-regional spillover is an important factor in the growth of output area. Big city such as Huabei region in China is a region gain enormous spillover effects from other regions, but relatively small impact spillover to other regions (Meng, Qu, 2007). In the contrary, *interregional economic* often face constraints caused by the *imperfect factor mobility*, *imperfect factor divisibility* and *imperfect mobility of goods and services* (Hoover, Giarratni, 1999). Often inter-regional trade creates asymmetric development of the region. Hughes and Holland (1994) found that in the Washington area has occurred impact backwash effects and spread effect between the core-periphery in the region. Spread effect of core-periphery to the region is not strong. The results of the analysis of trade and industry indicate that the added value of prime importance in the core region of influence of weak backward linkages to the periphery. In contrast, economic growth in the periphery is more likely to be felt by core region due to the magnitude of the backward linkages of the periphery.

Besides demographic factors, spatial and export-import affecting the economic performance of the region, the more important factor is human resources. Superior human resources are capable in stimulating and produce variety of innovations and new technologies. Technological invention and innovation will stimulate economic diversification, creating a chain of economy; generate more complex economy and stable (Hausman, et al., 2011).

The newest study of this research is to assess the economic benefits that occur between regions due to the economic interaction between the regions. The results show that there is an economic paradox occurred in eastern Indonesia, especially in the region of Sulawesi and East Kalimantan. Both regions rich in natural resources in agriculture, fishery, plantation and mining but is still a small contribution to the development of Indonesia. So far the economic disparities are often seen as the impact of development, but in this study further explore how inter-regional linkage pattern as a result of imbalances between regions. This research is expected to enrich the study of the economic linkages between the regions. On the other hand, the results of the study are expected to provide information and give you the option of government in formulating economic development between regions in Indonesia.

The method used to answer the research questions is inter-regional input-output (IRIO). IRIO is not only to estimate the stimulus production region of origin due to the increase in the final demand of other regions, but also the effect of final demand from other regions (Kwangmoon et al., 2010). The IRIO method can only be estimated and simulated in the table of final demand, while the intermediate input cannot be used as a basis to conduct inter-regional policy simulations. Therefore, further research is strongly recommended using the Computable General Equilibrium (CGE).

2. Data and Method

2.1 Data

The data used in this research is secondary data inter-regional input-output (IRIO) sourced from the Central Statistics Agency (BPS), Indonesia. The IRIO data used is the data in year 2005 because the data for the year 2011 is not yet available. Furthermore, the data are adjusted and estimated to the Year 2011 by using the technique of RAS. To meet the RAS technique, Gross Domestic Product data is collected from every region. The data are used to estimate and project the IRIO data in 2011. The estimated data is the data in 1 period, that is year 2011.

2.2 Method

The method is non-survey research or indirectly approach with a technique using RAS. RAS method is required to estimate coefficients of technology and trade between regions (Miller, Blair, 2005; Capello, Nijkamp, 2009). Leontief (1936) coefficient of technology is the basis to justify and estimate the value of the coefficient multiplier. The value of the coefficient multiplier is the ratio of inputs used in a particular sector and region ROI (rest of Indonesia) to the total use of inputs in the area.

$$A_{ij}^{AA} = \frac{x_{ij}^{AA}}{x_j^A} \quad ; \quad A_{ij}^{AB} = \frac{x_{ij}^{AB}}{x_j^B} \quad \text{..... (1)}$$

A_{ij}^{AA} = The coefficient input from the i sector in A region used j sector in A region

x_{ij}^{AA} =The used of i input sector from A region by j sector in A region

x_j^A = The total of use in i input sector by j sector in certain region

A_{ij}^{AB} =The coefficient input in trade between region

x_j^{AB} =The use of sector i output from A region, as the j input sector in B region

x_j^B =The total of use in input of j sector in B region

A =The matirx of input coefficient

Based on Isard (1951), Miller and Blair (2009) the IO inter-regional model with 5 regions can be formulated:

$$X = (I - A)^{-1} Y = B.Y \quad \text{..... (2)}$$

Where X, A, Y and B each of them is the output vector, matrix coefficient of inter-regional input, final demand vector and invers matrix of inter-regional leontief.

2.3 Data Projection

The IRIO data in 2005 can be estimated to Year 2011 with a number of considerations: (1) technology is relatively stable coefficient and (2) the structure of the economy of the region has not changed. Some of these considerations do not interfere with the basic assumption that the analysis of input-output (1) Linearity, (2) and proportionality (3) additivity and (4) homogeneity. The number of sectors is projected to consist of 35 sectors.

3. Results And Discussion

The economic linkages is based on the analysis of the region around sulawesi, South Sulawesi, East Java dan East Kalimantan.

3.1 Around Sulawesi

The results of this study is to describe the relationship and interaction between the region of South Sulawesi, the region around Sulawesi, East Kalimantan and East Java, as well as the entire region. Relations between the regions reflected on the effect of spillover, the feedback and inter-regional multiplier.

The region around Sulawesi is characterized as an agricultural region. The agricultural sector is the sector that produces the largest output in the economy. However, the sector has smaller added value than the other sectors. The sectors that generate most major spillover effect on the economy of the region around Sulawesi are the sector of air transport, electricity, gas and water,

construction and pulp and paper industries. In details the value of interregional multiplier effect, spillover and feedback in the region around Sulawesi are presented in Table 1.

Table 1. Impact of interregional, spillover and feedback in the region around Sulawesi

No	Sector	Interregional Multiplier Effect	Feedback Effect	Spillover Effect	Total Multiplier Effect
1	Air transportation	1.8504	0.0002	0.5483	2.3989
2	Building/Infrastructure	1.6426	0.0002	0.4929	2.1358
3	Electricity, gas & water	1.6852	0.0002	0.4661	2.1514
4	Pulp & Paper Industry	1.1317	0.0004	0.4535	1.5856
5	Footwear Industry	1.2842	0.0007	0.3830	1.6679
6	Land Industry	1.5005	0.0001	0.3296	1.8302
7	Rubber Industry	1.1408	0.0007	0.3116	1.4531
8	Water Transportation	1.3827	0.0001	0.2848	1.6677
9	Hotel & Restaurant	1.5932	0.0002	0.2437	1.8371
10	Iron & Steel Industry	1.7124	0.0002	0.2393	1.9519
Total multiplier		45.103	0.0057	6.4478	51.556

Source: Table IRIO-RAS 2011 after being processed

Based on the estimation in Table 1 above, it shows the total interregional multiplier effect, feedback and spillover to the economy of the region around Sulawesi with other regions amounted to 45.103 respectively, 0.0057 and 6.4478. That influence reflects that if final demand across all sectors each increased by 1 in the region around Sulawesi then the output of the economy in the region around Sulawesi will increase by 45 103. The increase in economic output around Sulawesi region will give a spillover effect on other regions (South Sulawesi, East Java, East Kalimantan and ROI) of 6.4478. The increase in output of other regions gives feedback to the economic output of the regions around Sulawesi in 0.0057.

The sector, which generates a multiplier effect, is the transportation sector. The second and third sectors that give major contribution to the region are the sector of infrastructure and the electricity, gas and water. On the other hand, the value of the feedback effect of these three sectors is smaller than the footwear and rubber industry. It means that the performance of the transportation sector, electricity and infrastructure provide a good influence to other regions, but the feedback effect is still smaller than the footwear industry and rubber industry. It shows that the economic performance of other regions provides a better effect on the footwear and rubber industry compare to transportation, infrastructure and electricity sectors.

The role of the air transportation sector is driven by the growing needs. Currently, the industry and infrastructure of aviation develop in the region of Sulawesi. The transport sector is opened in order to open access and facilitate investment in various regions in Indonesia. The development of the transportation sector is expected to improve the economic performance of the region and reduce economic disparities between regions. The development of the air transportation sector followed by the development of the infrastructure sector and the electricity and water sectors. To strengthen inter-regional connectivity, the development of infrastructure becomes a priority. The infrastructure sector linearly follows the performance of air transportation. Furthermore, the electricity and water sector follow the development of the air transportation and infrastructure sector.

The result indicates that the spillover effect the around Sulawesi to the whole region (Indonesia) is about 6.4478. On the other hand, the entire region (Indonesia) gives small feedback effects (0.0057) to the region around Sulawesi. It shows the economic benefit received by the region around Sulawesi is still low. That happens because other regions are able to meet between the sources of the home region than any other regions. On the other hand, the region around Sulawesi requires relatively large intermediate inputs from other regions. The economy interaction becomes not symmetric due to the influence of economic power between regions and industries. Although some sectors in the region around Sulawesi has a good performance, but the economy interaction is still weak. It also indicates that the area around Sulawesi still relatively dependent on

other regions in Indonesia. In detail total interregional multiplier, spillover and feedback on Sulawesi of the other is presented in Figure 1.

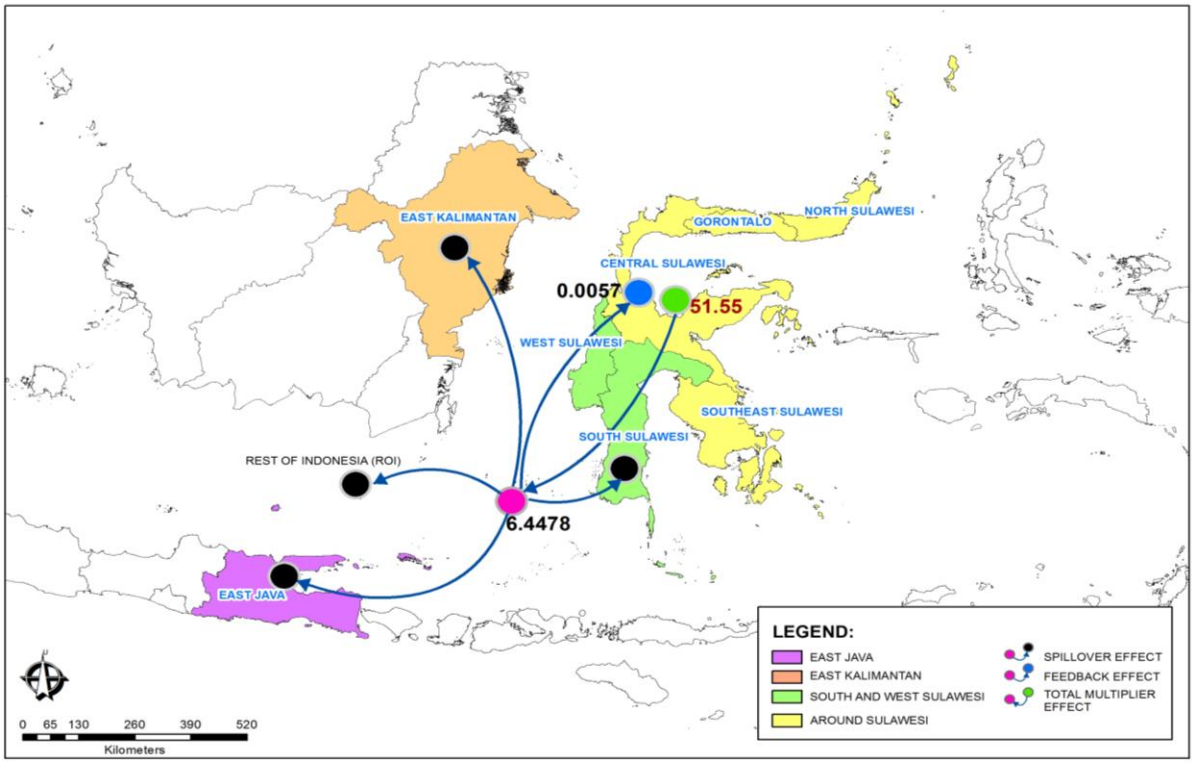

Fig. 1. Total interregional multiplier, spillover and feedback in Around Sulawesi

3.2 South Sulawesi

South Sulawesi region has started to develop into a regional industrialization and trade (initially still agriculture). However, the agricultural sector has not been able to participate to the maximum in driving regional economic output. There are three main sectors that produce spillover effect and the multiplier effect that the air transport sector, the sector of electricity, gas and water, as well as the textile industry. The influence of interregional, spillover, feedback in South Sulawesi presented in Table 2.

Table 2. Effect *interregional*, *spillover* and *feedback* in South Sulawesi

No	Sector	Interregional Multiplier Effect	Feedback Effect	Spillover Effect	Total Multiplier Effect
1	Air transportation	1.3989	0.0003	0.7488	2.1481
2	Building/Infrastructure	1.2789	0.0003	0.6081	1.8874
3	Electricity, gas & water	1.4458	0.0007	0.5654	2.0118
4	Pulp & Paper Industry	1.3605	0.0012	0.5653	1.9271
5	Footwear Industry	1.2204	0.0002	0.4691	1.6897
6	Land Industry	1.2094	0.0006	0.4534	1.6633
7	Rubber Industry	1.3233	0.0002	0.4489	1.7725
8	Water Transportation	1.4920	0.0005	0.4315	1.9241
9	Hotel & Restaurant	1.2110	0.0014	0.3982	1.6106
10	Iron & Steel Industry	1.6120	0.0003	0.3617	1.9739
Total multiplier		44.727	0.0098	8.6444	53.381

Source: Table IRIO-RAS 2011 after being processed

Based on the estimation in Table 2, it shows that the total interregional multiplier effect, feedback and spillover to the economy of South Sulawesi with other regions amounted to 44.727, 0.0098 and 8.6444. These values reflect the increase in economic output in South Sulawesi region will provide spillover impact in Indonesia (the region around Sulawesi, East Java, East Kalimantan and ROI) of 8644. The increase in output throughout the region (Indonesia) provides feedback to the output of economic in South Sulawesi region about 0.0098.

As in around Sulawesi, the air transportation sector in South Sulawesi begins to grow compared to other sectors. South Sulawesi region is a transit area of the flight path from western to eastern Indonesia, and vice versa. Low volume increased significantly due to the influence of investment, the mobility of people and the economic development of the region. Along with the development of the air transportation sector and investment and development of the region, the need for electricity and water sector increase. But the performance of these two sectors has a feedback effect that is still smaller than the other regions.

The sectors, which have a better feedback effect is the textile, rubber and petrochemical industry. These three sectors are not only influenced by the economic performance of the area of origin, but also by other regions. It reflects the economic linkages between regions provide substantial benefits to those industries. The development of the industrial sector in South Sulawesi has developed because of agglomeration economies have been formed. The industrial area in South Sulawesi (as a growth pole) gradually gives spread effect and creates economic linkages between regions.

In general, the estimation results indicate that South Sulawesi is a region that most influence spillover to other regions (greater than in the areas of Sulawesi, East Java and East Kalimantan). However, the number of the feedback effect of the whole region (Indonesia) to the South Sulawesi at 0.0098. The feedback influence of South Sulawesi is still greater than the area around Sulawesi. It shows that the economic interaction of South Sulawesi is still better than other area around Sulawesi. However, the value of the effect of feedback in South Sulawesi is still low compared to East Java. It shows the economic performance of East Java is better than South Sulawesi. In detail the total interregional multiplier effect, spillover and feedback in South Sulawesi is presented in Figure 2.

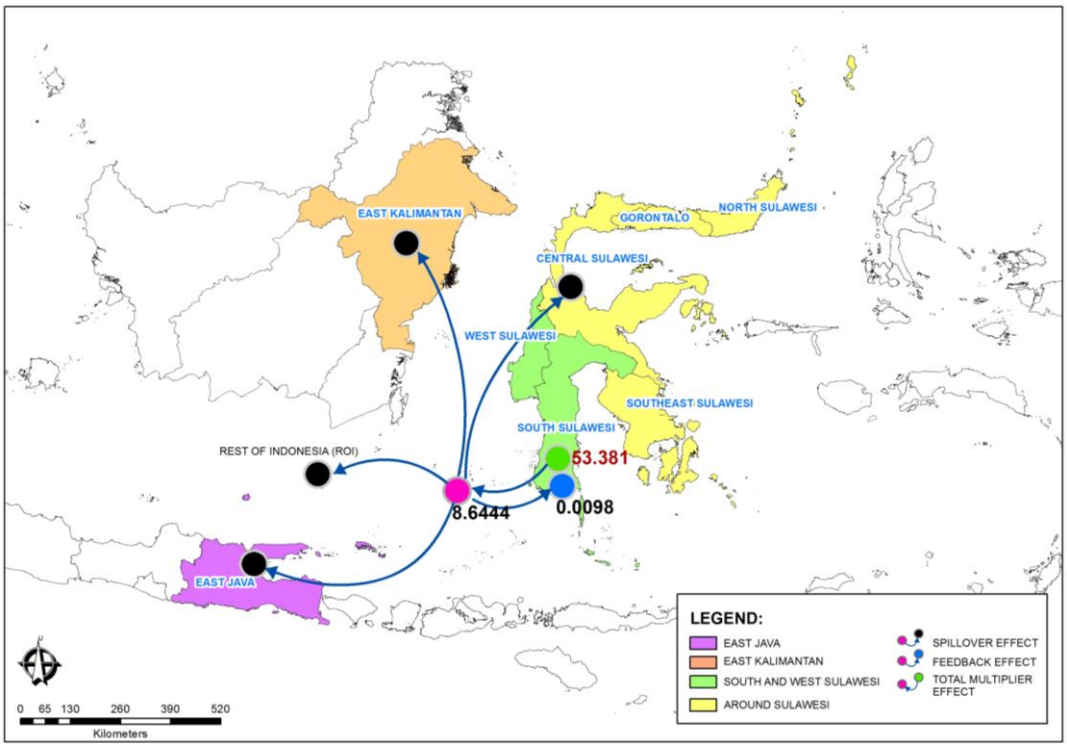

Fig. 2. Total *interregional multiplier*, *spillover* and *feedback* in South Sulawesi

3.3 East Java

East Java is an area, which, is very strong and complex of industrial agglomeration and economic activity. The economic output of East Java is far surpasses than other areas. The role of East Java in Java Island and Indonesia is very important to support the provision of inputs among other areas. The greatest impact of spillover to other areas is the industrial sector of electrical machinery and electrical equipment, the palm oil industry and air transportation. Those three sectors provide a high feedback to East Java region. The influence of interregional, spillover and feedback in East Java are presented in Table 3.

Table 3. The Effect of *inter-regional*, *spillover* and *feedback* in East Java

No	Sector	Interregional Multiplier Effect	Feedback Effect	Spillover Effect	Total Multiplier Effect
1	Electrical Machinery Industry	1.3580	0.0118	0.7604	2.1302
2	Oil Palm Industry	1.3893	0.0063	0.6012	1.9969
3	Air Transportation	1.6268	0.0057	0.4383	2.0708
4	Rubber Industry	1.5216	0.0033	0.3582	1.8830
5	Water Transportation	1.2331	0.0042	0.3399	1.5772
6	Textile Industry	1.2756	0.0025	0.3049	1.5829
7	Electricity, Gas & Water	1.6669	0.0020	0.1765	1.8454
8	Building	1.7336	0.0036	0.1520	1.8892
9	Seafood Processing Industry	1.4196	0.0015	0.1384	1.5595
10	Land Transportation	1.0590	0.0017	0.1324	1.1931
	Total multiplier	46.782	0.0762	4.7758	51.721

Source: Table IRIO-RAS after being processed

Based on the estimation in Table 3 shows the total interregional multiplier effect, feedback and spillover to the economy of East Java with other regions about to 46 782 respectively, 0.0762 and 4.7758. That influence reflects that the economy of East Java will provide spillover effect on the entire territory or Indonesia (Sulawesi, East Kalimantan and ROI) of 4.7758. The increase in output throughout the region (Indonesia) gives the feedback effects to the economic output of the East Java region of 0.0762.

However, the total value of the spillover effect of the East Java region to other regions is much lower than South Sulawesi region, the region around Sulawesi and East Kalimantan. On the other hand, the feedback effects of sectors in East Java are relatively better than other regions (South Sulawesi, the region around Sulawesi and East Kalimantan). This reflects that the East Java's economy gives a little spread effect on the economy of the entire region. East Java's economy tends to give a backwash effect to other regions. The region in East Java gets big benefit and advantage from interactions with regions in Indonesia.

The advantages are; first, the area of East Java gets benefit from the economic performance of other regions. It shows from the value of the feedback effect (0.0762) in the East Java region. Second, economic performance provides a large output of the East Java region but little impact on the economies of other regions. Third, the economic development of East Java will continue to stimulate the economic development of the area, but other areas will be difficult to accelerate when there is no innovation and change in national policy.

The condition of economic and industry are better than any other regions (Sulawesi and Kalimantan). The economic activity in East Java has the effect of forward linkage and backward linkage better than other regions. It shows that inputs for industrial activity are available in larger quantities and industrial output can be absorbed by the import and export market. Demographics and technology factors in East Java provides a better economic scale and scope than other regions.

It causes economic agglomeration to grow and develop thereby increasing industrial investment. This situation led the East Java region grows faster than other regions. The asymmetrical developments led to economic imbalances between the regions. In details, the total effect of interregional, spillover and feedback in East Java is presented in Figure 3.

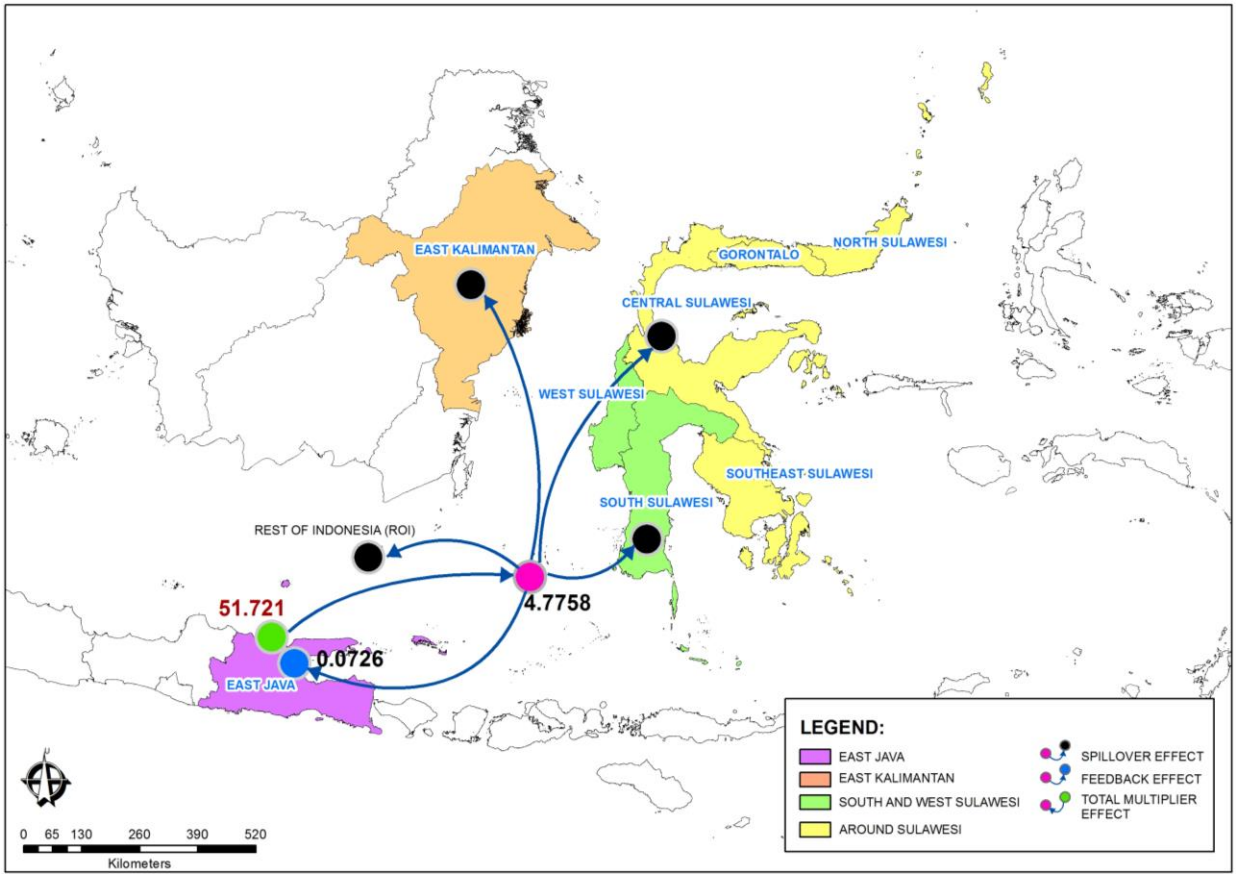

Fig. 3. Total *interregional*, *spillover* and *feedback* in East Java

3.4 East Kalimantan

Unlike the three areas previously discussed, East Kalimantan is a region characterized by the extraction of natural resource economics. More than 40 % of the economy of East Kalimantan region comes from coal mining and oil. But the performance of the mining sector only encourages the economic performance of the supply side but it is still smaller than the demand side. Some factors that may cause the performance of the coal sector to be low on the supply side are (1) production for coal mines is not into the domestic market, (2) the product is sold exports, (3) the product is marketed in the form of raw material that has low value added, and (4) the use of coal by another country or region is larger than the region of origin.

Unfortunately, the potential of mining in East Kalimantan has not been optimally used by the government. That's why East Kalimantan has not been able to reduce disparities with other regions in Indonesia. The government prefers raw materials to be exported, without considering the construction of coal processing industry. Coal actually can be used as a source of energy that can propel industrial and economic development. Government needs to have strict regulations so that coal is not exported to other countries in the form of raw materials. This regulation is expected to increase the use of coal energy for processing a wide variety of industries in Kalimantan. It will also create inter-regional linkage is more strategic in Indonesia.

The sectors that provide the biggest spillover effect to other areas are the industrial sector and improved transportation, textile industry and husbandry. Many activities of coal mining, oil palm plantation and industrial tree plantations led to an increased need for transportation in East Kalimantan. It makes the industrial transportation sector in East Kalimantan give a large spillover

effect on other regions (especially in East Java). The sector that gets the feedback effect in East Kalimantan is the textile industry and husbandry. The interregional multiplier effect, spillover and feedback in East Kalimantan are presented in Table 4.

Table 4. The impact of *interregional*, *spillover* and *feedback* di East Kalimantan

No	Sector	Interregional Multiplier Effect	Feedback Effect	Spillover Effect	Total Multiplier Effect
1	Transportation Equipment Industry	1.3683	0.0004	0.4905	1.8592
2	Textile Industry	1.3122	0.0012	0.4426	1.7560
3	Animal Husbandry	1.3970	0.0009	0.3586	1.7565
4	Footwear Industry	2.0377	0.0003	0.3359	2.3739
5	Iron & Steel Industry	2.0377	0.0003	0.3359	2.3739
6	Metal Industry	2.0377	0.0003	0.3359	2.3739
7	Electric Machine Industry	2.0377	0.0003	0.3359	2.3739
8	Cement Industry	1.0377	0.0003	0.3359	1.3739
9	Hotel & Restaurant	1.5066	0.0008	0.2962	1.8036
10	Air Transportation	1.6485	0.0006	0.2866	1.9357
Total multiplier		49.321	0.0112	5.4608	54.793

Source: Table IRIO-RAS 2011 after being processed

Based on the estimation in Table 4 above shows the total multiplier effect of interregional, feedback and spillover to the economy of East Kalimantan with other regions amounted to 49.321 respectively, 0.0112 and 5.4608. The influence reflects that the increasing output of the economy of East Kalimantan will provide spillover effects on other regions (South, East Java and ROI) of 5.4608. The increase in output of other regions provides feedback effect on the output of the regional economy in East Kalimantan at 0.0112.

In general, the estimation results in East Kalimantan shows that the effect of spillover to other regions is smaller than the area around Sulawesi and South Sulawesi, but larger than the area of East Java. The feedback effects obtained by the East Kalimantan region is 0.0112. The performance of the mining sector in East Kalimantan is not yet optimal in boosting the regional economy. The interregional total multiplier effect, spillover and feedback in East Kalimantan are presented in Figure 4.

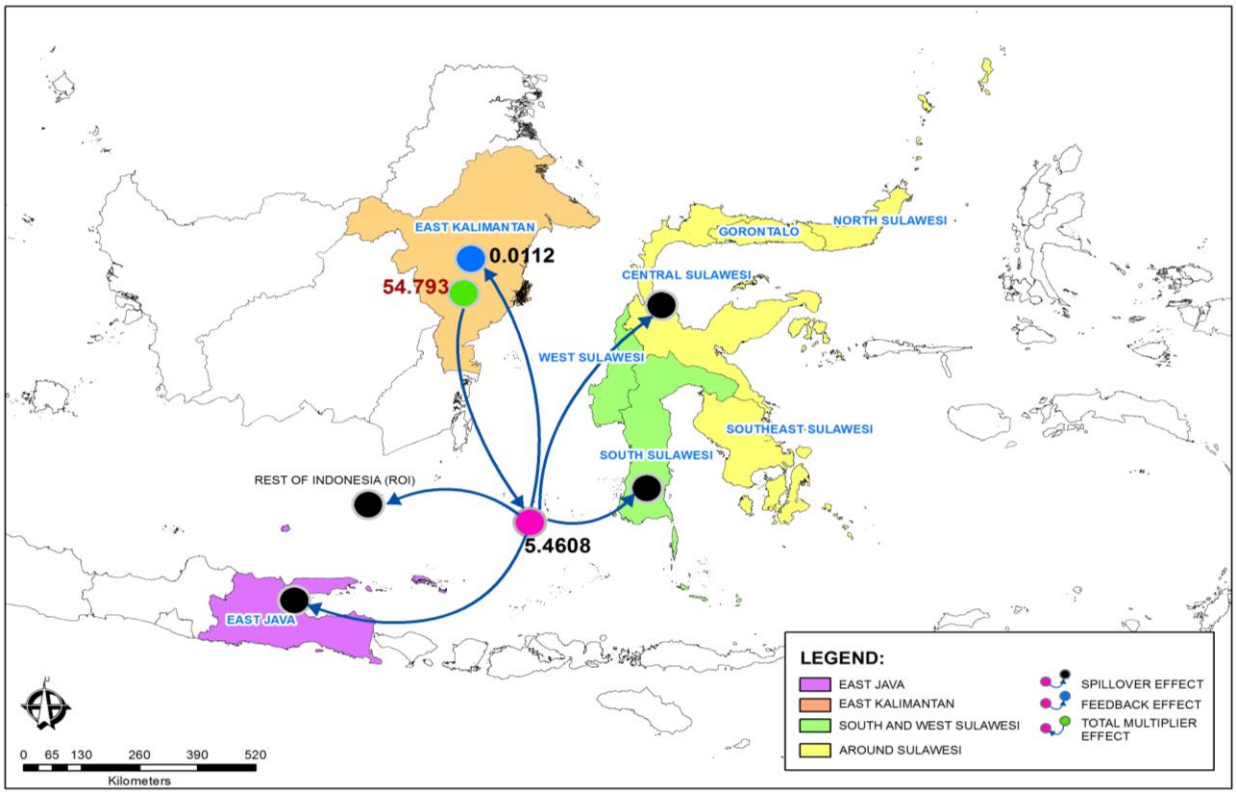

Fig. 4. The impact of *interregional*, *spillover* and *feedback* in East Kalimantan

Based on the analysis in each region, the important findings in the research are presented in the Table 5 below.

Table 5. Important findings in the research

No	Sector	Interregional Multiplier Effect	Feedback Effect	Spillover Effect	Total Multiplier Effect
The Around Sulawesi					
1	Air transportation	1.8504	0.0002	0.5483	2.3989
2	Building/Infrastructure	1.6426	0.0002	0.4929	2.1358
3	Electricity, gas & water	1.6852	0.0002	0.4661	2.1514
South Sulawesi					
1	Air transportation	1.3989	0.0003	0.7488	2.1481
2	Building/Infrastructure	1.2789	0.0003	0.6081	1.8874
3	Electricity, gas & water	1.4458	0.0007	0.5654	2.0118
East Java					
1	Electrical Machinery Industry	1.3580	0.0118	0.7604	2.1302
2	Oil Palm Industry	1.3893	0.0063	0.6012	1.9969
3	Air Transportation	1.6268	0.0057	0.4383	2.0708
East Kalimantan					
1	Transportation Equipment Industry	1.3683	0.0004	0.4905	1.8592
2	Textile Industry	1.3122	0.0012	0.4426	1.7560
3	Animal Husbandry	1.3970	0.0009	0.3586	1.7565

4. Conclusion

This study has been assessing the economic linkages between regions in Indonesia through the projection IRIO 2005 to 2011. This estimation is based on the pattern and inter-regional economic interaction in Indonesia. Patterns and interactions that occur in the area around Sulawesi with other regions yet give better feedback effect. It appears once; the economic performance of the region around Sulawesi is lower than in other regions (see spillover effect and feedback) even though in some sectors the economic performance is quite good. It also shows how the quality of the region's economy around Sulawesi with another region is.

East Java region gives contribution and influence to the Indonesian economy. Unfortunately, the economic impact on the region of East Java has led to another backwash effect. That means the economic growth of East Java provides little effect on other regions. However, economic growth of Sulawesi gives large spillover effect on the region of East Java.

East Java is still very dominant in the economic dimension because of agglomeration and industrialization is very strong. East Java generate spillover effect of the smallest compared with other regions, but it produces a feedback effect is greatest. It shows the area of East Java provides a spread effect is relatively small compared with other regions, but tends to cause backwash effect. Economic activity in East Java appears to be more efficient and effective because of the agglomeration is still very strong.

The influence of agglomeration provides enormous benefits to the economy in East Java. Industry in East Java has a forward linkage and backward linkage better than other regions. It encourages investment and growing industries in East Java, while other regions are relatively slow development (except in South Sulawesi).

South Sulawesi region's position is very strategic, because it is able to bridge in eastern Indonesia. That is why South Sulawesi gives the greatest spillover affect compared with other areas and obtains feedback effect is better than the area around Sulawesi. In addition, South Sulawesi gives the feedback effect better than the area around Sulawesi.

Although the mining sector in East Kalimantan is a major sector, but the sector has not been able to push to the maximum economic performance in East Kalimantan and other regions. Inter-regional spillover and feedback in East Kalimantan is more influenced by the industry.

Indonesia's economy would create imbalances of development and environmental limitations when there is no strategic policy of the government. Strategic policy to build in the eastern Indonesian region is (1) Encourage the increase of capital expenditure of the central government to the island of Sulawesi and East Kalimantan, (2) Encourage private investment in the industrial sector and production base in the island of Sulawesi and East Kalimantan, (3) Encourage South Sulawesi region as an economic hub towards other regions, especially the eastern part of Indonesia, (4) increase and improve inter-connectivity between South Sulawesi region by region around Sulawesi in order to create economic linkages across the region, (5) encourage the inter-regional capital movement to Sulawesi and East Kalimantan to ensure equal distribution of development and stable environment among regions, (6) create linkage sectors (downstream industry) mining (East Kalimantan) and plantations (Sulawesi) within and between regions, and (8) Strengthen economic territory of interregional Linkage toward interregional Partnership.

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Appendix

The formulation:

$$X=\begin{pmatrix} X^{A} \\ X^{B} \\ X^{C} \\ X^{D} \\ X^{E} \end{pmatrix}, A=\begin{pmatrix} X_{ij}^{AA} & X_{ij}^{AB} & X_{ij}^{AC} & X_{ij}^{AD} & X_{ij}^{AE} \\ X_{ij}^{BA} & X_{ij}^{BB} & X_{ij}^{BC} & X_{ij}^{BD} & X_{ij}^{BE} \\ X_{ij}^{CA} & X_{ij}^{CB} & X_{ij}^{CC} & X_{ij}^{CD} & X_{ij}^{CE} \\ X_{ij}^{DA} & X_{ij}^{DB} & X_{ij}^{DC} & X_{ij}^{DD} & X_{ij}^{DE} \\ X_{ij}^{EA} & X_{ij}^{EB} & X_{ij}^{EC} & X_{ij}^{ED} & X_{ij}^{EE} \end{pmatrix}, Y=\begin{pmatrix} Y^{A} \\ Y^{B} \\ Y^{C} \\ Y^{D} \\ Y^{E} \end{pmatrix}, B=\begin{pmatrix} B_{ij}^{AA} & B_{ij}^{AB} & B_{ij}^{AC} & B_{ij}^{AD} & B_{ij}^{AE} \\ B_{ij}^{BA} & B_{ij}^{BB} & B_{ij}^{BC} & B_{ij}^{BD} & B_{ij}^{BE} \\ B_{ij}^{CA} & B_{ij}^{CB} & B_{ij}^{CC} & B_{ij}^{CD} & B_{ij}^{CE} \\ B_{ij}^{DA} & B_{ij}^{DB} & B_{ij}^{DC} & B_{ij}^{DD} & B_{ij}^{DE} \\ B_{ij}^{EA} & B_{ij}^{EB} & B_{ij}^{EC} & B_{ij}^{ED} & B_{ij}^{EE} \end{pmatrix}$$

If X represents each sector and region, then matrix B can be decomposed into three parts, there are:

$$\begin{pmatrix} B_{ij}^{AA} & B_{ij}^{AB} & B_{ij}^{AC} & B_{ij}^{AD} & B_{ij}^{AE} \\ B_{ij}^{BA} & B_{ij}^{BB} & B_{ij}^{BC} & B_{ij}^{BD} & B_{ij}^{BE} \\ B_{ij}^{CA} & B_{ij}^{CB} & B_{ij}^{CC} & B_{ij}^{CD} & B_{ij}^{CE} \\ B_{ij}^{DA} & B_{ij}^{DB} & B_{ij}^{DC} & B_{ij}^{DD} & B_{ij}^{DE} \\ B_{ij}^{EA} & B_{ij}^{EB} & B_{ij}^{ED} & B_{ij}^{ED} & B_{ij}^{EE} \end{pmatrix} = \begin{pmatrix} \left(I - A^{AA}\right)^{-1} & 0 & 0 & 0 & 0 \\ 0 & \left(I - A^{BB}\right)^{-1} & 0 & 0 & 0 \\ 0 & 0 & \left(I - A^{CC}\right)^{-1} & 0 & 0 \\ 0 & 0 & 0 & \left(I - A^{DD}\right)^{-1} & 0 \\ 0 & 0 & 0 & 0 & \left(I - A^{EE}\right)^{-1} \end{pmatrix} +$$

$$\begin{pmatrix} B^{AA} - \left(I - A^{AA}\right)^{-1} & 0 & 0 & 0 & 0 \\ 0 & B^{BB} - \left(I - A^{\mathbf{B}B}\right)^{-1} & 0 & 0 & 0 \\ 0 & 0 & B^{CC} - \left(I - A^{CC}\right)^{-1} & 0 & 0 \\ 0 & 0 & 0 & B - \left(I - A^{DD}\right)^{-1} & 0 \\ 0 & 0 & 0 & 0 & B - \left(I - A^{EE}\right)^{-1} \end{pmatrix} +$$

$$\begin{pmatrix} 0 & B_{ij}^{AB} & B_{ij}^{AC} & B_{ij}^{AD} & B_{ij}^{AE} \\ B_{ij}^{BA} & 0 & B_{ij}^{BC} & B_{ij}^{BD} & B_{ij}^{BE} \\ B_{ij}^{CA} & B_{ij}^{CB} & 0 & B_{ij}^{CD} & B_{ij}^{CE} \\ B_{ij}^{DA} & B_{ij}^{DB} & B_{ij}^{DC} & 0 & B_{ij}^{DE} \\ B_{ij}^{EA} & B_{ijij}^{EB} & B_{ij}^{EC} & B_{ij}^{ED} & 0 \end{pmatrix}$$

The output of region A can get by combining the equation (2) with the equation above with this formulation:

$$X^{A} = \left(I - A^{AA}\right)^{-1} Y + \left[B - \left(I - A^{AA}\right)^{-1}\right] Y + \left[B^{AB} Y^{2} + B^{AC} Y^{3} + B^{AD} Y^{4} + B^{AE} Y^{5}\right] \quad \text{.....(3)}$$

The equation (3) contains with three parts, there are (1) reflecting the inter-regional multiplier effect, (2) feedback effect and (3) interregional spillover effect. The interregional spillover effect reflects the total added value as the result from one sector towards the economy due to the high final demand. *Interregional spillover effect* reflects the effect of economy output as the result of certain sector in a region due to the output demand from another sector. Feedback effect reflects the feedback from the region, which have the spillover effect. Feedback effect is the interaction effect of both inter-regional trades.

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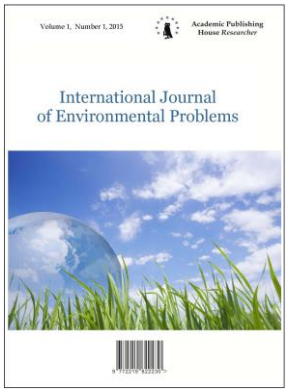

Living with a Fatal Choice: Effects of Slaughterhouse Activities on Residents' Health in Osogbo, Nigeria

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Abstract

Background. This study assessed the effects of slaughterhouse activities on the health of surrounding residents in Osogbo Nigeria. This was with a view to suggesting policy response capable of enhancing healthy environment in the city and others with similar background.

Materials and Methods. A total of thirty three slaughterhouses identified in the study area out of which fifteen (45 %) were randomly selected for questionnaire administration. This is followed by stratification of 500metre radial distance from the respective residences surrounding them into 1-250 metres and 251-500 metres. In the strata, questionnaires were administered on 98 residents comprising 44 and 54 in the first and second strata respectively. Data analysis was done using cross tabulation and Chi-square tests.

Results. Findings revealed that slaughterhouse activities pollute the environment and this inevitably had negative impacts on the health of the surrounding residents. From the findings, 80 % of the slaughterhouses were located near water bodies. The study also found that most of the surrounding residences were infested by flies and mosquitoes with varying degrees as distance increases from the slaughterhouses. This study established that the quality of the environment varied with distance from the slaughterhouses. Similarly, the proportion of residents that treated malaria and diarrhoea continually in the study areas was 69.4 % and 70.4 % respectively.

Conclusion: These findings have implications for policy making towards planning effective and sustainable intervention strategies for slaughterhouse activities in Osogbo and other cities with similar background.

Keywords: Slaughterhouse, Solid waste, Effluents, Pathogens, Carcass, Osogbo, Nigeria.

1. Introduction

Slaughterhouses are known all over the world to pollute the environment either directly or indirectly from their various processes. They are frequently located near urban centres and enormous amount of waste are produced (Adeyemo, 2002). The location of facilities and services such as slaughterhouses in the neighbourhood is very important. This is because it provides residents with easy access to purchase of meats for household consumption. However, its activities pose danger on the immediate environment and health of surrounding residents (Bello, Oyedemi, 2009) due to the negation of the principle of separation of incompatible land uses upheld by physical planning. This is no doubt prevalent in developing countries where enforcement of

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development control is at its lowest ebb (Kawu et al., 2012). The dilution of residential neighbourhoods with slaughterhouses has left residents with no choice than to live with the fatal hazards associated with the slaughterhouse activities in their vicinity.

Pollution emanating from slaughterhouse operations in Nigeria has become a source of concern because conventional methods for disposal of waste are inadequate (Adeyemo, 2002; Kawu et al., 2012; Olowoporoku, 2013). Nwanta et al (Daramola, 2006) also noted that the numerous wastes produced by slaughterhouse operation not only pose a significant challenge to effective environmental management, they are also associated with decrease in air quality of the environment and transferable of several infectious diseases. The major concern is the risks to health of residents living with these fatal choices in their neighbourhoods.

Slaughterhouses generate significant quantities of secondary wastes which are not environmentally friendly. For instance, Aniebo, Wekhe and Okoli (Nwanta et al., 2008) noted that the blood from a single cow carcass if discharge directly into a sewer line, the effluent load would be equivalent to the total sewage produced by 50 people on average day. These wastes are highly organic with relatively high levels of suspended solid, liquid and fat. The solid wastes include condemn meat, undigested ingesta, bones, horns, hairs, aborted foetuses and grit while the liquid wastes usually compose dissolved solid, blood gut contents, undigested feed, urine and wastewater (Aniebo et al., 2009). In Nigeria, these wastes are indiscriminately and improperly discharged. This makes the environment unsightly, occupy useful space and odorous which in turn attracts flies, mosquitoes, rodents and other disease vectors thus causing nuisance in the neighbourhood.

Another peculiar issue in Nigerian cities is the location of slaughterhouses. Due to their required large quantity of water (Adeyemo et al., 2002), slaughterhouses are usually located near water bodies or places with high water table in order to gain unhampered access to water for processing of their activities (Kuyeli, 2007). Effluents from these slaughterhouses are directly discharged into streams and rivers without any form of treatment and the slaughtered meat is washed with the contaminated water (Kosamu et al., 2011). This could lead to transmission of pathogens to humans causing infections such as Coli, Bacillus, Salmonella infections, Brucellosis, methemoglobinemia and Helminthic diseases (Adelagan, 2002). This is aside the heat, smoke and noise which emanates from slaughterhouse.

These fatal issues related to slaughterhouse activities have aroused the interest of researchers in Nigeria (Daramola, 2006; Aniebo et al., 2009; Esona, 2004). However, they have only focused on the impact of slaughterhouse activities on nearby water bodies and the health effect of the water pollution. Other studies in this regard include Omole and Ogbiye (Omole, Longe, 2008), Afon and Fadare (Omole, Ogbiye, 2013) and Bello and Oyedemi (Bello, Oyedemi, 2009). These past studies did not extensively discuss the pollution and health effects with due consideration for the surrounding residents. Also, effects of distance on pollution and health effects were not extensively considered. The intent of this study is therefore to establish the variation in polluting and health effects based on distances from slaughterhouses and residences surrounding them in Osogbo Nigeria. Also, the study discussed the socio-economic attributes of the surrounding residents. This type of study is imperative as it will elucidate the fatal choices confronting residents living with slaughterhouses in their neighbourhoods.

2. Materials and Methods

The study area is Osogbo, the capital of Osun State, located in south-western part of Nigeria. Following the creation of Osun State in 1991, Osogbo assumed the status of a state capital. It has two local government areas (LGAs) which are Osogbo and Olorunda. Over the years, Osogbo has witnessed tremendous growth both spatially and demographically. Its nature as a nodal settlement and initial establishment of a railway station are factors in the growth of Osogbo. According to the 2006 population census, Osogbo had 287,156 inhabitants (Federal Government of Nigeria, 2007).

This research was carried out on slaughterhouses in Osogbo and their vicinities. As common to most Nigerian cities, slaughterhouses are located in different areas of Osogbo township. They are characterized with locations among residences with no regards for their compatibility. This is against the existence of legislations governing the location and operations of slaughterhouses both at the state and federal level. For instance the federal level, the government promulgated the National Environmental Standard and Regulation Enforcement act on sanitation and waste control. Notwithstanding the existence of these legislation, the yearnings of the growing population

for meat coupled with the laxity on the part of the government have made the location and operations of slaughterhouses unfriendly.

A total of thirty-three slaughterhouses were identified in Osogbo, Nigeria. For this study fifteen slaughterhouses were randomly selected for questionnaire administration and field observation. Simple random technique was adopted in sourcing information from an operator in each of the slaughterhouses selected. Thus, fifteen operators were sampled on which questionnaire were administered. Data collected through the survey include number of cow's slaughtered daily, purpose of location of slaughterhouses, waste handling practices in the slaughterhouses and complaints by surrounding slaughterhouse operators.

Residential buildings within 500metre radius around the slaughterhouses were selected for questionnaire administration. The residential buildings were further stratified into 1-250metres and 251-500metres radius from the selected slaughterhouses. In the stratified distance from the slaughterhouses, every 5th residential building was sampled sequel to enumeration of buildings based on street numbering system and counting of buildings where houses were not numbered. Questionnaire was administered on an adult in each of the each of the selected residential buildings. A total of 98 residents were selected from the 98 selected buildings on which questionnaires were administered. The sample comprises 44 respondents within 1-250metres radius from the slaughterhouse and 54 respondents within 251-500metres radius from the slaughterhouses. Data collected through the questionnaire survey are socio-economic attributes of the residents, level of prevalence of infestation of disease vectors, and health conditions. Analysis of the data was done using cross tabulation and Chi-square Test.

3. Results and Discussions

This section discusses the profile of slaughterhouses and their activities, profile of the respondents, effects of slaughterhouse activities on residents and residents' reported health condition in the study area.

Profile of Slaughterhouses

Findings made on the number of cows slaughtered in the slaughterhouses daily and the purpose of location of the slaughterhouses. Findings revealed that 60.0 % of the slaughterhouses slaughtered between 1-3 cows daily, 26.6 % slaughtered 4-7 cows daily and the remaining 13.4 % slaughtered more than seven cows daily. Further findings revealed that majority of the slaughterhouses slaughter between 1-3 cows daily. The average number of cows slaughtered daily in the study area is two.

Investigations were made on the rationale behind the location of slaughterhouses in the respective neighbourhood within the city. Respondents were allowed to tick multiple responses as a combination of factors could be responsible for locating a slaughterhouse in a particular area. Findings revealed that 36.4 % of the slaughterhouses were located due to proximity to a river/stream, 27.3 % were sited because the area is with a high water table, 12.1 % were located because of closeness to the market and availability of land was responsible for the location of 15.2 % of the slaughterhouses. Further investigations revealed 80 % of the slaughterhouses were sited in their location because of the presence of a nearby water body while 60% of the slaughterhouses were located in places with high water table. These findings confirmed the studies of (Kuyeli, 2007) and (Adeyemo et al., 2002) that slaughterhouses in the developing world are usually located near water bodies because of huge volume of water used for their activities. Physical observation revealed that majority of the slaughterhouses contravened the physical planning laws. This is because they were located within lands allocated as setbacks along river courses.

Table 1. Waste Disposal Practices in Slaughterhouses

Practices	Frequency (%)
Solid Waste Disposal	
Burning	3 (10.0%)
Dump on Vacant Land (Beside Slaughterhouse)	15 (50.0%)
Dump in Nearby Bush	2 (6.7%)

Dump along Drainage	3 (10.0%)
Collected on Request	7 (23.3%)
Total	****30 (100.0%)**
Liquid Waste Disposal	
Channel to Nearby Stream	11(55.0%)
Channel to Nearby Drainage	9 (45.0%)
Total	****17 (100.0%)**
Complaint By Surrounding Residents	
Foul Odour	15 (78.9%)
Foul Odour and Air Pollution	4 (21.1%)
Total	**** 19 (100.0%)**

*These were more than the number of questionnaires administered because respondents were allowed to choose multiple options

Findings on waste disposal methods in the slaughterhouse are contained in Table 1. Slaughterhouse operators were allowed to select the various solid waste disposal methods they employed. Findings revealed that 10.0 % of the operators burned their waste, 50.0 % dumped their waste on vacant land in the premises of the slaughterhouses, 6.7 % dumped their waste in the bush, 10.0 % dumped in the drainage while 23.3 % gave their waste out on request. Further findings revealed that all the slaughterhouses dumped their solid waste on the vacant land in the premises of the slaughterhouses. Physical observation revealed that undigested ingesta, dungs, aborted foetus, bones and horns are the major solid wastes generated in Nigerian slaughterhouses. All the waste disposal methods employed by the operators fall short of the waste disposal standard enacted by the Federal Government of Nigeria. The dump of this waste around the slaughterhouses could be responsible for the highly pungent odour, infestation of flies and diseases vectors in the neighbourhoods where these slaughterhouses are located.

Investigations were made into the management of wastewater in the slaughterhouses. Two methods of waste water management were identified in the study area. Findings revealed that 55.0 % of the slaughterhouses discharged their liquid waste into the nearby water bodies while 45.0 % discharged their liquid waste into nearby drains in their neighbourhood. The indiscriminate discharge of waste water could contaminate the nearby water bodies and also cause drains around the slaughterhouses to be filled with slaughterhouse effluents. This could be responsible for the highly unpleasant odour emanating several metres away from the premise of the slaughterhouses.

Findings from slaughterhouses on complaints about their activities by surrounding residents revealed that 78.9 % of the neighbouring residents have complained about the foul odour emanating from the slaughterhouses while 21.1 % of the operators claimed residents have complained about foul odour and air pollution emanating from the slaughterhouses. These odourous emissions from slaughterhouses could cause eye, nose and throat irritation, headache, nausea, diarrhoea, cough, chest tightness shortness of breath, stress, drowsiness and alterations of mood (Afon, Fadare, 2011). All these health symptoms can occur at the time of exposure and may persist for longer periods of time as well as aggravate existing medical conditions in sensitive individuals such as asthmatic patients.

Profile of the Surrounding Residents

The profile of the respondents discussed consists of gender, age, educational attainment, income status and type of building. Investigation into gender distribution of respondents across the two residential strata around the slaughterhouses revealed that the percentage of male and female living within 1-250 metres radius from the slaughterhouses were 38.6 % and 61.4 % respectively while the percentage of male and female respondents who live within 251-500 metrs radius from the slaughterhouses stood at 39.8 % and 60.2 % respectively. Closely associated with gender is age. The age of the respondents was grouped into four: teenagers (those with less than 20 years); young adults (21 to 39 years); elderly adults (40 to 59 years) and old people 60 years and above). Across

the two strata, majority of the residents (80.6 %) were adults (21 to 59 years), 8.2 % were teenagers and 10.1 % were old people (60 years and above). The overall mean age was 40years. This indicates that respondents were of age that could make them environmentally-conscious of what happens in their neighbourhood.

According to Theodori and Luloff (Schiffman, 2006) and Fransson and Gärling (Theodori, Luloff, 2002), the level of education people raises their consciousness about what operates in their surroundings. Findings on educational attainment revealed that all the respondents sampled acquired a form of formal education. In the first stratum, respondents with primary, secondary and tertiary education stood at 25.0 %, 56.8 % and 18.2 % respectively while the percentage of residents with primary, secondary and tertiary education living within 251-500 metres, from the slaughterhouses were 11.1 %, 38.9 % and 50.0 % respectively. This findings was further established by Chi-square result ($\chi 2$ =14.011; p=0.003) which indicated that a significant association exists between educational level of the people and the distance of their residence to the slaughterhouses. This means that educational level of people influence their residential decision to live around slaughterhouses in the study area.

For easy understanding, residents' monthly income was classified into three. Income below ₦20,000 categorised as low income. The reason is that the minimum wage at the federal level in Nigeria is ₦18,000 while it ranges from ₦15,000 to ₦20,000 in the states of the federation. The medium monthly income was categorised from ₦21,000 to ₦60,000 while residents earning ₦61,000 and above were categorised as high income earners. In the first stratum (1-250 metres), 81.8 % of the residents were low income earners. Those within the medium and high income group were 13.6 % and 4.5 % respectively. In the second (251-500 metres), residents in the low, medium and high income groups were 87.0 %, 7.4% and 5.6 % respectively. The overall mean monthly income was ₦30,627.

Investigations were made into the household sizes of neighbours of slaughterhouses in the study area. A household was defined as a person or group of people with shared cooking, sanitary and living arrangements. Based on this, the household size of the residents was categorised into three. The household sizes of one to five members were categorised as small, those with six to ten members as medium while those with more than ten members was categorised as large. In the first stratum (1-250metres), respondents with small, medium and large households stood at 43.2 %, 44.5 % and 2.3 % respectively while in the second stratum (251-500metres) respondents having small and medium households were 61.1 % and 38.9 % respectively. The mean household sizes for the first and second strata were six and five persons respectively.

Type of houses around the slaughterhouses was categorised into five: face-face (bungalow), face-face (storey), Flat (bungalow), flat (storey) and duplex. Findings revealed that majority (61.3 %) of the residents sampled lived in multi-habitation buildings (face-face) while the remaining 39.6 % lived in single-family apartments. One important fact to note is that multi-habitation buildings may have to do with is presence of many families living within the building.

Table 2. Profile of Respondents

Attribute	1-250 (m)	251-500 (m)	Total
	Frequency (%)	Frequency (%)	Frequency (%)
Gender			
Male	17 (38.6)	22 (40.7)	39 (39.8)
Female	27 (61.4)	32 (59.3)	59 (60.2)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Age (years)			
≤ 20	3 (6.8)	6 (11.1)	9 (8.2)
21-39	20 (45.5)	20 (37.0)	40 (40.8)
40-59	15 (34.1)	24 (44.4)	39 (39.8)
60 ≥	6 (13.6)	4 (7.4)	10 (10.2)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**

Educational Level			
Primary	11 (25.0)	6 (11.1)	17 (17.3)
Secondary	25 (56.8)	21 (38.9)	46 (46.9)
Tertiary	8 (18.2)	27 (50.0)	35 (35.8
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Average Monthly Income			
≤₦20,000	36 (81.8)	47 (87.0)	83 (84.7)
₦21,000- ₦60,000	6 (13.6)	4 (7.4)	10 (10.2)
≥₦61,000	2 (4.5)	3 (5.6)	5 (5.1)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Household Size			
1-5	19 (43.2)	33 (61.1)	52 (53.1)
6-10	24 (54.5)	21 (38.9)	45 (45.9)
Above 10	1 (2.3)	0 (0.0)	1 (1.0)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Type of Building			
Face to face (Bungalow)	19 (43.2)	8 (14.8)	27 (27.6)
Face to face (Storey Building)	16 (13.4)	17 (31.5)	33 (33.7)
Flat (Bungalow)	9 (20.5)	12 (22.2)	21 (21.4)
Flat (Storey Building)	0 (0.0)	15 (27.2)	15 (15.3)
Duplex	0 (0.0)	2 (3.7)	2 (2.0)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**

Prevalence of Infestation of Disease Vectors in Respondents Homes

Table 3 contained information on prevalence of disease vectors in respondents' homes in the stratified areas. It is imperative to consider the disease vectors the respondents are vulnerable to. This is necessary because disease vectors may determine the infections respondents' experience.

Table 3. Prevalence of Disease Vectors from Slaughterhouse Activities

Prevalence	**1-250 (m)**	**251-500 (m)**	**Total**
	Frequency (%)	Frequency (%)	Frequency (%)
Level of Prevalence of Flies			
Always	41 (93.2)	34 (63.0)	75 (76.5)
Sometimes	3 (6.8)	20 (37.0)	23 (23.5)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Level of Prevalence of Rodents			
Always	12 (27.3)	8 (14.8)	20 (20.4)
Sometimes	29 (65.9)	42 (77.8)	71 (72.4)
Rarely	3 (6.8)	4 (7.4)	7 (7.1)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Level of Prevalence of Mosquitoes			
Always	37 (84.1)	32 (59.3)	69 (70.4)
Sometimes	7 (15.9)	22 (40.7)	29 (29.6)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**

Investigation into level of prevalence of flies in residents' homes revealed that 76.5 % of the residents living around slaughterhouses were always infested by flies in their homes while 23.5 %

were sometimes infested by flies in their homes. This overall percentage of residents always infested by flies is less than the percentage of residents always infested by flies in the first stratum (1-250 metres) (93.2 %) but greater than those always infested by flies in second stratum (63.10 %). This was further established by Chi-square value ($\chi 2$ =14.3; p=0.001) which indicated a significant association between the level of prevalence of flies and the distance of respondents residence to the slaughterhouses.

On the findings on infestation of rodents in respondents homes, 27.3 %, 65.9 % and 6.8 % of the respondents living within 1-250 metres from the slaughterhouses were always, sometimes and rarely infested by rodents while respondents living within 251-500 metres from the slaughterhouses who were always, sometimes and rarely infested by rodents were 14.8 %, 77.8 % and 7.4 % respectively. Findings on the level of prevalence of mosquitoes in respondents' homes revealed that 84.1 % and 15.9 % of the residents living within 1-250metres were always and sometimes infested by mosquitoes in their homes while in the second stratum (251-500 metres) 59.3 % of the residents were always infested by mosquitoes while the remain 40.7 % were sometimes infested by mosquitoes. These findings were further established by Chi-square results ($\chi 2$ =12.17; p=0.007) which indicates that a significant association exist between level of prevalence of mosquitoes and the distance of their residence to the slaughterhouse.

Evaluation of Residents' Reported Health Condition

Sequel to the investigation on level of prevalence of disease vectors in respondents' houses, Table 4 contains findings on slaughterhouse activities and respondent's reported ill-health condition across the two strata as at the time of the study.

Table 4. Reported Health Effects of Slaughterhouse Activities

Period of Infection	**1-250 (m)**	**251-500 (m)**	**Total**
	Frequency (%)	Frequency (%)	Frequency (%)
Last Time Member of Household was Infected by Malaria			
3 months	34 (77.3)	34 (63.0)	68 (69.4)
6 months	9 (20.4)	19 (35.2)	28 (28.6)
Over 6 months	1 (2.3)	1 (1.8)	2 (2.0)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Last Time Member of Household was Infected by Typhoid			
3 months	17 (38.6)	8 (14.8)	25 (25.5)
6 months	21 (47.8)	34 (63.0)	55 (56.1)
Over 6 months	6 (13.6)	12 (22.2)	18 (18.4)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Last Time Member of Household was Infected by Cholera			
3 months	5 (11.4)	1 (1.9)	6 (6.1)
6 months	13 (29.5)	13 (24.1)	26 (26.5)
Over 6 months	26 (59.1)	40 (74.0)	66 (67.4)
Total	**44 (100.0)**	**54 (100.0)**	**98 (100.0)**
Last Time Member of Household was Infected by Diarrhea			
3 months	32 (72.8)	39 (72.2)	71 (72.4)
6 months	12 (27.2)	15 (27.8)	27 (27.6)
Total	**44 (100.0)**	**54 (100.00**	**98 (100.0)**

Findings were made on the last time household members were infected with diseases. Findings from residents living within 1-250 metres from the slaughterhouses revealed that 77.3%, 20.5% and 2.3% of the residents treated malaria in their household in the last three months, six months and above six months respectively. In the second stratum (251-500metres), 63.0% of the respondents treated malaria 3months ago, 35.2% were infected with malaria six months ago while

1.9% of the respondents were infected with malaria more than six months ago. Investigations were made into the interval of infection of typhoid within the two residential strata. In the first stratum, the percentage of respondents who were infected with typhoid three months ago, six months ago and more than six months stood at 38.6%, 47.8% and 13.6% respectively while respondents within 251-500metre radius who contracted typhoid three months ago, six months ago and more than six months ago stood at 14.8%, 63.0% and 22.2% respectively. This findings was further established by Chi-square results ($\chi 2 = 9.14$; $p = 0.027$) which indicated that there is a significant association between the last time the people were infected with typhoid and the distance of their residence to the slaughterhouse.

Residents also expressed the last time were infected by cholera and diarrhoea in their households. In the first stratum 11.4% of the households were infected with cholera in the last three months, 29.5% were infected by cholera in the last six months, and 51.9% of the respondents did not experience cholera in over six months. Respondents within 251-500metre radius whose household were infected with cholera three months ago stood at 1.9%, 24.1% was infected six months ago and 74.0% were infected in their households with cholera more than six months ago. This findings was further established as Chi-square analysis ($\chi^2 = 8.03$; $p = 0.045$) indicate a significant association between the time the people were infected with cholera and the distance of their residence to the slaughterhouses. Findings on last time a member of respondents household were infected with diarrhoea. In the first 1-250metre radius around the slaughterhouse 78.2% of the residents' households were infected with diarrhoea in the last three months while the remaining 27.2 % claimed they were infected by diarrhoea in the last six months. In the second stratum, 72.2 % and 27.8 % of the respondents were infected with diarrhoea in the last three months and six months respectively.

The average per household vulnerability to diseases (malaria, typhoid, diarrhoea and cholera) was determined using the average household sizes in each residential zone. It was revealed that the average per household susceptibility to diseases in the first stratum (1-250metre radius) was 264 persons while in the second stratum (251-500 metres) the average per household susceptibility to disease was 270 persons. These findings are consistent with the results of some earlier studies (Bello, Oyedemi, 2009; Olowoporoku, 2013) which have indicated that there is a significant statistical association between meat industry activities and health quality of residents around it.

In order to examine the relationship between residents' profile on prevalence of infestation of flies and mosquitoes in respondents' homes, cross tabulation was conducted on the variables. Two socioeconomic characteristics (income and level of education) found in literature (Olowoporoku, 2013) to be factors influencing the habitation of residences close to slaughterhouses and its consequential health effects were examined. The analysis revealed that across the two strata, 84.6 % of low income earners were constantly infested by flies in their homes and 83.6 % were constantly infested by mosquitoes in their homes. This is in contrast to the proportion of residents belonging to medium (10.2 %) and high income (5.1 %) categories. This could be attributed to possible unavailability of insect resisting facilities in their homes due to their low income. Also, findings revealed that across the two residential strata, residents with minimum of secondary education were the most concerned about the presence of flies and mosquitoes in their homes (82.6 %). This could be based on their better knowledge of the harm posed by these disease vectors in their homes.

The relationship between residents' income and their health status was also determined. This was measured in terms of the last time the respondents were treated for malaria, typhoid, diarrhoea and cholera. Findings across the two strata revealed that 84.6 % of low income groups treated malaria, 83.6 % treated typhoid and 84.6 % treated diarrhoea frequently in a period of six months to the time of the study. This finding is in tandem with reports of United States Embassy Nigeria (2011) that the most inflicted income group by malaria in Nigeria is the low income group. They account for 65 % of the population and are slaves to infectious diseases such as malaria, typhoid, diarrhoea, cholera etc.

4. Conclusion and Recommendations

This study assessed the relationship between the locations of slaughterhouses and the quality of health of residents living around slaughterhouses in Osogbo. Also, the study examined the socio-economic characteristics of residents as a determinant of their level of vulnerability to health hazards emanating from slaughterhouses in their neighbourhood. This study revealed that slaughterhouse activities pollute the environment and consequently have negative impact on the health of its surrounding residents based on the distance of their residences to the slaughterhouses. The study found out that the level of prevalence of infestation of mosquitoes and flies is more predominant on residents whose homes are closer to the slaughterhouses.

Findings established that residents within the low income group felt the impact of the prevalence of disease vectors. The study established that increase in the distance between residents' homes and slaughterhouses is directly proportional to the level of infestation of residents' homes by flies and mosquitoes. This implies that there is variation in environmental deterioration as distance increases from the slaughterhouses. This may account for the incessant infection of residents with typhoid, malaria and diarrhoea in the first stratum. It can therefore be concluded that the farther the location of the residences to the slaughterhouses, the lesser the degree of the respective polluting and health effects of the slaughterhouse activities on the environment and residents in the study area.

These results on the assessment of the polluting and health effects of slaughterhouse have policy implications for sustainable development both in Nigeria and countries of similar urban settings. For instance, failure to manage the activities of these fatal choices in neighbouhoods could lead to epidemics. Other associated implications of poor management of the fatal choices include high financial and economic cost, direct medical cost associated with curbing epidemics and loss of productivity. Therefore appropriate measures should be taken to reduce its impact on the health of those who live with this conflicting necessity of life. The government should enforce existing laws related to meat industry activities and promulgation of new ones. Also, due the nature and quantity of waste generated from slaughterhouses, they should be considered as industrial waste and not mixed with municipal waste.

Waste management facilities and services should be provided at slaughterhouses and operators should be levied on waste generated based on the number of cows slaughtered. This will be a good source of revenue for the government. Also, design standards and siting restriction such as setbacks and buffers from residences and also from water bodies should be ensured. Residents' education on possible impacts of pollution from slaughterhouse waste should be embarked upon by both governmental and non-governmental organizations with interest in environmental and public health.

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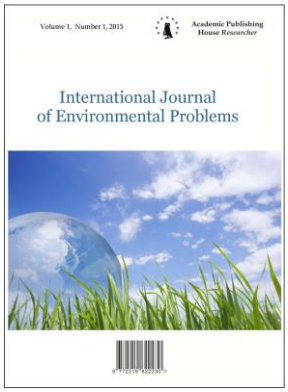

Generation of Molecular Genetic Markers in Studies of Genetic Structures of Horses

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Abstract

An overview of the different generations of molecular genetic markers used to solve the traditional problems of breeding work – exception errors of origin; determine the distribution of genetic flow of agricultural animal species; the identification of genetic systems, polymorphism of which is associated with variability of economically valuable traits are carried out. The history of the use of genotypic characteristics as "signalview" to predict the desired manifestation of economically valuable traits, starting with the works of A.S. Serebrovsky, are discussed. The need for consistent study of the gene pools of native breeds with a unique capacity of adaptation to specific ecological and geographical factors, in which farm animal breeding, is underlined. It is noted the similarity of molecular-genetic systems involved in adaptation, in particular, to high-altitude hypoxia, such mammal species as domestic horses and people. As an example of adaptation to high-altitude conditions of breeding discusses the specificity of Karachai horses. The different methods of genomic scanning (multigene genotyping) using as genomic anchors randomly selected decanucleotide (RAPD-PCR), sequences of microsatellite loci (ISSR-PCR markers), retrotransposons (IRAP-PCR markers) are discussed. It is noted the particularities of the representation in animal genomes microsatellite loci, DNA and RNA transposons.

Keywords: molecular genetic markers, blood groups, electrophoretic variants of proteins, microsatellites, transposons, endogenous retroviruses

1. Введение

В докладе 2007 года Организации по продовольствию и сельскому хозяйству при ООН (Food and Agriculture Organization – FAO, 2007, 2015) отмечается, что до сих пор управление генетическими ресурсами животных сельскохозяйственных видов в глобальном масштабе ограничивается отсутствием концептуальных разработок. FAO положила начало идентификации ключевых элементов такой концепции, используя как исходную точку определение устойчивого использования, предложенное Конвенцией по Биологическому Разнообразию (Convention on Biological Diversity – CBD): “устойчивое использование – это использование компонентов биологического разнообразия таким путем и с такой скоростью, которые не приводят к долговременному уменьшению биологического разнообразия, таким образом поддерживая его потенциал, чтобы удовлетворять потребности и стремления

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настоящих и будущих поколений" (Статья 2 CBD) (Kalinitchenko et al., 2014, 2016). В этой связи FAO выдвигает необходимость выявления, изучения и сохранения локально адаптированных пород. Признаки приспособленности к конкретным средовым условиям особо важны, поскольку они не могут быть легко созданы отбором за короткий период времени. Предложенный FAO подход предполагает, что генетическое усовершенствование должно быть тесно связано с вовлечением в селекционную работу локально адаптированных генетических ресурсов, препятствуя утрате генофондов пород с уникальными характеристиками. Именно РФ остается одной из стран, наиболее богатых генетическим разнообразием животных сельскохозяйственных видов в связи с большим размером территорий и обилием разных эколого-географических условий разведения животных. В ряде работ отмечается, что многие отечественные породы, незначительно уступая родственным иностранным по продуктивности и технологическим свойствам, превосходят их по приспособленности к местным условиям, долголетию, устойчивости к отдельным заболеваниям, вкусовым и биологическим качествам продукции и другим признакам (Kalashnikov et al., 2011).

В настоящее время основным видом использования лошадей в большинстве развитых стран мира стал конный спорт. Одним из популярных видов конного спорта во всем мире является дистанционный конный пробег. В этом виде спорта от лошадей требуется выносливость и хорошее здоровье. В нашей стране существуют отечественные породы, соответствующие этим требованиям, одной из которых является карачаевская порода лошадей. Выступления карачаевских лошадей в дистанционных конных пробегах убедительно показывают, что они обладают отличными дистанционными задатками (Parphenov, Khotov, 2010).

Популяционная генетика пород лошадей имеет особое значение еще и для выявления молекулярно-генетических механизмов адаптации крупных млекопитающих, в том числе и человека, к экстремальным условиям воспроизводства, в частности, к высокогорной гипоксии.

Воспроизводство крупных травоядных на большой высоте над уровнем моря приводит к существенным физиологическим и метаболическим изменениям, связанным с интенсивным селекционным давлением окислительного стресса, UV радиации и других факторов, зависящих от специфических видовых характеристик. В этой связи особого внимания требуют исследования генетических структур горных пород лошадей, в том числе и отечественной карачаевской породы, высоко адаптированных к горным условиям, что может способствовать не только консолидации генофондов пород, но и рассматриваться как модель для поисков генетических основ адаптации к высокогорным условиям разных видов.

2. Материалы и методы

Сравнительный анализ молекулярно-генетических механизмов адаптации к горным условиям воспроизводства крупных наземных млекопитающих позволил обнаружить определенное сходство между биохимическими системами, вовлекаемыми в этот процесс, у разных видов, в частности, человека и горных пород лошадей по гену EPAS1 (Hendrickson S.L., 2013). В работе Hendrickson S.L. (2013) выполнено сравнение результатов геномного сканирования между одичавшей популяцией лошадей Анд, потомков, завезенных из Испании в Анды в 1500 годах, и пород их испанских родственников. В результате анализа 50-ти тысячных ДНК микроматриц с мононуклеотидными заменами (Single Nucleotide Polymorphism – SNPs) в геномах домашней лошади выявлен 131 ген – кандидат на участие в адаптации к высокогорным условиям. Наиболее выраженное отличие обнаружено по гену EPAS1 в метаболическом пути, индуцируемым гипоксией (Hypoxia-Induction-Pathway – HIF). Отличия обнаружены также в семействе генов цитохрома P450 3A, которые могут объясняться влиянием эндемической растительности в условиях высокогорья, используемой лошадьми в качестве корма. Отличия по гену тенуерину (tenuerin 2 – TENM2) свидетельствуют о том, что нервная деятельность также важна для адаптации к высокогорью. На основании анализа полиморфизма по копийности коротких геномных участков (Copy Number Variability – CNV) обнаружено сходство между высокогорными породами лошадей и их отличие от равнинных; отмечается, что в повышенную частоту CNV

у горных пород вовлекаются районы локализации семи генов, продукты которых участвуют в связывании гема, метаболизме ретинола, а также в том же метаболическом пути HIF.

3. Результаты и их обсуждение

В общем, полученные данные свидетельствуют о том, что для крупных млекопитающих при их адаптации к высокогорью универсальную для разных видов и определяющую роль играет метаболический путь HIF, однако в этот процесс могут вовлекаться и другие метаболические пути в связи с особенностью эволюции вида и уникальной экологией высокогорья. Таким образом, генофонды отечественных горных пород лошадей могут представлять специальный интерес для данных исследований. К представителям местных отечественных пород относятся такие, как карачаевская и алтайская.

Карачаевская порода лошадей уникальна тем, что она универсальна и успешно может использоваться в сельскохозяйственном производстве, для массового конного спорта и пробегов, конной охоты и туризма, цирка и проката, службы в армии и милиции. До настоящего времени они остаются незаменимыми для пограничных войск, в трудных горных районах Средней Азии, Закавказья и Закарпатья.

Лошади карачаевской породы разводятся в Карачаево-Черкесской республике, а также за ее пределами. В республике функционирует Карачаевский конный завод и 17 коневодческих ферм. В Министерстве сельского хозяйства Карачаево-Черкесской республики совместно с кафедрой коневодства Московской сельскохозяйственной академии им. К.А. Тимирязева организован централизованный племенной учет карачаевских лошадей и их паспортизация (Parphenov, Khotov, 2010). В последние годы интерес к карачаеской породе вышел за пределы республики. Созданы племенные коневодческие хозяйства в следующих районах: в Предгорном Ставропольского края, Можайском Московской области и в других. Кроме этого разведением карачаевской породы лошадей занимаются частные коннозаводчики Чехии и Германии.

Суть основных задач, решением которых занимается популяционная генетика, состоит в том, чтобы научиться получать организмы с необходимыми хозяйственно-ценными признаками, адаптированные к конкретным агроэкологическим регионам разведения, не имеющие врожденных патологий и высокоустойчивые к различным заболеваниям. Именно сейчас сельское хозяйство остро нуждается в резком ускорении процесса создания новых пород животных, сочетающих устойчивость к биотическим и абиотическим факторам стресса с высоким потенциалом продуктивности (Kalinitchenko et al., 2014, 2016).

Попытки маркирования наследственной предрасположенности к проявлению различных фенотипических признаков в отечественной генетике сельскохозяйственных видов начались с работ А.С. Серебровского еще в 20-е годы (Серебровский, 1928). Он предложил использовать фенотипические признаки с моногенным характером наследования в качестве «сигналий» – генетических маркеров – для облегчения контроля передачи определенного генетического материала в поколениях, и, соответственно, облегчения подбора и отбора организмов при формировании хозяйственно ценных групп. Идеи, заложенные А.С. Серебровским, широко применяются в настоящее время: сформировано направление, известное как «селекция с помощью маркеров» (Marker Assistant Selection – MAS). Его суть заключается в попытках выявления генетических маркеров (генов или последовательностей ДНК), которые были бы тесно сцеплены с «главными» генами хозяйственно-ценных признаков, а также могли бы маркировать гены, играющие ключевую роль в развитии различных генетических патологий, нарушений процессов метаболизма, устойчивости к патогенам.

В качестве одного из первых поколений молекулярно-генетических маркеров использовали группы крови. Если к применению термина «новые методы генетики» подходить со всей строгостью, то генотипирование по группам крови вряд ли можно включить в их число. Важным этапом в развитии иммуногенетики животных принято считать применение методов искусственной иммунизации с целью выявления антигенного состава эритроцитов. И сейчас метод типирования групп крови находит достаточно широкое практическое применение. Использования метода генотипирования по группам крови подробно рассматривается в работах К. Стормонта. (Stormont, 1951, 1958, 1967; Stormont,

Morris, 1992). Он подчеркивает, что применение методики типирования групп крови для идентификации индивидуумов и установления отцовства внесло неоценимый вклад в правильное регистрирование пород крупного рогатого скота. Сходные методы тестирования крови были затем последовательно адаптированы для работы с овцами, свиньями, лошадьми. Исследования систем групп крови лошадей разных пород проводятся в России более четырех десятилетий. За это время накоплена уникальная информационная база, в основном во Всероссийском институте коневодства. Формирование такой базы особенно важно для малочисленных популяций, находящихся на грани исчезновения, поскольку способствует развитию методов генетически обоснованных подходов к сохранению и совершенствованию их генофондов. Этот метод имеет и свои ограничения, поскольку анализ генетической изменчивости с применением иммунологических методов возможен при наличии донорского стада соответствующего вида, от которого можно получать эталонный набор антигенов для генотипирования групп крови, что является достаточно сложной экспериментальной задачей.

Следующим поколением молекулярно-генетических маркеров, применяемых для генотипирования животных сельскохозяйственных видов были электрофоретические варианты белков с известной биохимической функцией (генетико-биохимические маркеры). Время возникновения биохимической генетики относится к 50-60 годам и связано с трудами Маркерта и соавторов (Hunter, Markert, 1957; Markert, Miller, 1959). Тогда биохимическая генетика занималась исследованиями исключительно только диких видов, при этом использовался довольно скромный набор биохимических маркеров. Однако это новое направление оказало большое влияние как на традиционные направления в биологии, так и на расширение видов и генетических систем, вовлекаемых в исследования, которые ведутся в самых разнообразных и разноплановых направлениях: изучается онтогенез, сцепление и хромосомная локализация генов, тканевая и внутриклеточная специфичность их экспрессии, роль взаимодействия аллельных и неаллельных генов, влияние на генетическую структуру популяции различных форм отбора. Генетика полиморфных белков находит свое приложение в эволюционной и популяционной генетике. Однако особое место генетико-биохимические маркеры заняли в генотипировании животных сельскохозяйственных видов (Глазко, Созинов, 1993; Kaminski, 2011). В селекционной практике применение этих маркеров носит ограниченный характер, что обусловлено низким полиморфизмом, поскольку в общем, средняя гетерозиготность популяций, рассчитанная по этим маркерам, оценивается в 6 %. Эта оценка занижена по сравнению с истинной гетерозиготностью популяций, что объясняется двумя причинами. Во-первых, некоторые из аминокислотных замен не приводят к изменениям суммарного электрического заряда или молекулярной конфигурации, и, следовательно, не могут быть обнаружены методом электрофореза. Во-вторых, анализ белков позволяет тестировать изменения только в белок-кодирующих последовательностях ДНК экспрессирующихся генов. Но в геноме высших эукариот кодирующие аминокислотные последовательности составляют около 1 % от всего генома, значительную долю составляют повторяющиеся последовательности, сами структурные гены имеют экзон-интронную структуру. Ясно, что при анализе белкового полиморфизма от внимания исследователей ускользает большая часть генома. При этом в состав неанализируемых последовательностей могут входить функционально значимые участки. В этой связи, благодаря появлению полимеразной цепной реакции (Mullis, Faloona, 1987), позволяющей нарабатывать в доступном для генотипировании любого участка ДНК, появились методы оценок полиморфизма различных геномных элементов, в частности, длин микросателлитных локусов.

Микросателлиты или простые тандемные повторы – последовательности ДНК, состоящие из много раз повторенных олигонуклеотидов длиной в 1–6 нуклеотидов. Для них характерен высокий уровнень полиморфизма. Среди микросателлитов наиболее распространены динуклеотидные повторы. В популяционно-генетических исследованиях предметом изучения является полиморфизм микросателлитов, состоящих от 10 до 16 и более 16 динуклеотидных повторов. Полиморфизм их длины может быть следствием ошибок репликации, что было подтверждено экспериментально при изучении механизмов репликации *in vitro* (Ellegren et al., 1992). В большинстве случаев микросателлиты выявляются в некодирующих областях ДНК. Скорость мутирования микросателлитных

локусов по их длине оценивается в среднем, как 10-2 на локус за поколение, что в тысячу раз выше, чем оценки частот мутирования локусов, кодирующих структурные белки. Выдвинуто предложение, что наличие повторов, таких как GT, CA, CT, GA, GC или AT, повышает частоты рекомбинаций в генах, стимулируя образование специфичных вторичных структур ДНК (Ellegren et al., 1992). Изменение количества повторов внутри микросателлитных локусов предположительно связывают с процессом рекомбинации путем кроссинговера. Неравный кроссинговер в комбинации со случайным генетическим дрейфом и отбором влияют на накопление тандемных повторов. Повышенный интерес в настоящее время проявляется к структурно-функциональным механизмам воздействий микросателлитных локусов на процесс формирования генома. Их широко используют в качестве маркеров в работах по изучению особенностей генетических структур у различных видов млекопитающих, как на межвидовом, так и на внутривидовом уровнях. В России генотипированием лошадей разных пород по микросателлитам занимается только ВНИИ коневодства, имеющий международную сертификацию для выдачи генетических паспортов лошадей.

К настоящему времени опубликовано множество работ по генофондным характеристикам различных пород и внутрипородных групп лошадей, включающих результаты исследований полиморфизма по микросателлитам, лидером в этих исследованиях также является ВНИИ коневодства (Kalashnikov et al., 2011; Khrabrova, 2011; Zaitseva, 2010).

Геномные сканирования (Feofilov et al., 2011) – основная тенденция современной популяционной геномики. Для целей геномного сканирования используют от нескольких десятков или сотен маркеров до полного геномного сканирования – сиквенс генома.

Один из методов геномного сканирования – генотипирование по фрагментам ДНК разной длины, фланкированных инвертированным повтором случайно выбранного декануклеотида – метод RAPD (Random Amplified Polymorphic DNA) – наиболее простой из методов геномного сканирования, в котором, как правило, применяются праймеры длиной 10-20 п.н. с произвольными нуклеотидными последовательностями (Caetano-Anolles, 1994, 1996). В результате полимеразной цепной реакции (ПЦР или PCR) амплифицируются анонимные участки ДНК, длины продуктов амплификации анализируют с помощью электрофореза. Отсутствие или наличие соответствующих фрагментов определяет полиморфизм RAPD-маркеров. Метод RAPD быстрый, недорогой и дает возможность одновременной детекции большого количества локусов, однако этот метод чувствителен к условиям реакции, что может снизить воспроизводимость результатов и оценки уровеня полиморфизма. Считается, что изменчивость RAPD-маркеров нейтральна к факторам отбора, а также к эволюционным изменениям, в целом. Соответственно, эти маркеры удобны для оценки генетических взаимосвязей между генофондами на основании сканирования отдельных геномов по многим геномным участкам. Такие исследования выполнялись и на генофондах лошади Пржевальского, некоторых породах домашней лошади (Bailey, Lear, 1994).

Одними из разновидностей RAPD-маркеров являются ISSR-маркеры (Inter-Simple Sequence Repeat) (Zietkiewicz et al., 1994). Известно, что микросателлиты относительно равномерно распределены по геномам высших млекопитающих, частота их встречаемости в большей степени зависит от количества нуклеотидов в элементарной единице тандемного повтора (динуклеотидные микросателлиты встречаются чаще, чем тринуклеотидные и т.д.), примерно 5 % из них формируют инвертированные повторы на сравнительно коротких расстояниях (100 ~ 2000 пар оснований – п.о.). В 2009 г. геном домашней лошади был полностью секвенирован, подробно исследован его нуклеотидный состав, хромосомное распределение различных тандемных и диспергированных повторов, выполнено сравнение геномов представителей разных пород лошадей, составлена карта мононуклеотидных полиморфизмов (Single Nuvleotide Polymorphisms) (Wade et al., 2009).

Тандемные повторы представлены несколькими типами последовательностей: часть из них сконцентрирована в отдельных морфологических участках хромосом, такие как теломерные повторы и повторы в гетерохроматиновых перицентромерных участках, другие тандемные повторы рассеяны по всему геному. К наиболее широко исследуемым тандемным повторам в последнее время относятся последовательности микросателлитных локусов,

полиморфизм которых широко используется при подборе генетических маркеров в генетико-популяционных исследованиях, при картировании главных генов количественных признаков, в определении отцовства, диагностике некоторых наследственных заболеваний, в криминально-следственной экспертизе и т.п.

Диспергированные повторы подразделяются на два класса: I класс – ретротранспозоны, II класс – ДНК транспозоны. В геномах млекопитающих основной вклад в диспергированные повторы вносят ретротранспозоны. Ретротранспозоны подразделяются, в свою очередь, на эндогенные ретровирусы (ERV), содержащие длинные концевые повторы (Long Terminal Repeats – LTR), лишенные LTR с геном обратной транскриптазы (*pol*) и полиаденилированным 3' концом длинные диспергированные повторы (Long Interspersed Nuclear Elements) и неавтономные (без гена *pol)* короткие диспергированные повторы (SINE). ДНК транспозоны занимают небольшую часть генома домашней лошади, наибольший процент от генома приходится на семейство ретротранспозонов LINE1.

В связи с широкой представленностью в геномах млекопитающих участков гомологии к ретротранспозонам, сформировано следующее поколение молекулярно-генетических маркеров. Достаточно удобным методом оказалось использование в качестве праймера фрагмента LTR различных эндогенных ретровирусов (Inter-Retrotransposon Amplificated Polymorphisms – IRAP-PCR) (Liu et al., 2011; Van der Kuyl, 2011). Следует отметить, что распространенным явлением является элиминация из геномов хозяина всего тела эндогенного ретровируса при сохранении LTR, такие последовательности получили название LTR-Solo.

Геномы позвоночных, как правило, содержат большое количество элементов, которые были приобретены видом-хозяином в течение долгого времени (Yang, Bennetze, 2009). Традиционно считается, что эндогенные ретровирусы происходят от экзогенных ретровирусов и активно участвуют в эволюции геномов (Horie, et al., 2010). Выделяют три класса эндогенных ретровирусов. Так, для ERV класса I предполагается тесная связь с ретровирусами *Gammaretrovirus и Epsilonretrovirus*; для ERV класса II –*Alpharetrovirus*, *Betaretrovirus*, *Deltaretrovirus*, и*Lentivirus*; для ERV класса III – с *Spumavirus* (Liu et al., 2011; Van der Kuyl, 2011). Описаны такие последовательности и в геномах домашней лошади (Equus caballns) (Van der Kuyl, 2011).

Сравнительный анализ представленности тандемных и диспергированных повторов в геноме домашней лошади позволяет полагать, что использование методов геномного сканирования с применением ISSR-PCR и IRAP-PCR маркеров может позволить оценить полиморфизм наиболее изменчивых геномных элементов в целях выявления породоспецифичных генофондных характеристик.

Еще одним высоко полиморфным геномным элементом, участвующим в глубоких геномных преобразованиях, является ДНК транспозон хелитрон. Перемещение генетического материала между изолированными видами, названное горизонтальным переносом, описано во многих работах. У эукариот это было выявлено по ряду генов (Thomas et al., 2010), а также по транспозирующимся элементам (Van der Kuyl, 2011). Особое место среди таких транспозирующихся элементов занимают ДНК транспозоны, которые реплицируются по типу «катящегося кольца». Они получили название хелитронов. Идентификационным признаком хелитронов является присутствие нуклеотидов 5' TC и 3' CTRR на конце, а также палиндрома длиной в 16 или 20 пар оснований (п.о.) близко от 3' конца. Присутствие таких последовательностей выявлено у разных таксонов, от грибов до позвоночных (Liu et al., 2011; Thomas et al., 2010). Последовательности палиндрома (TCCCGTGC_GAT_GCACGGGA) и фланги высоко консервативны, внутренняя часть часто включает фрагменты других генетических элементов, в том числе и других хелитронов. Хелитроны, в отличие от большинства других ДНК транспозонов, вместо транспозазы для репликации ДНК используют собственный белок, PIF1 подобную ДНК геликазу, объединяющую все хелитроны. Этот белок имеет высокую степень гомологии с бактериальным белком RC (rolling-circle), известным своим участием в горизонтальном переносе генов устойчивости к антибиотикам между разными бактериями. Как и их бактериальные «родственники», некоторые хелитроны функционируют как "машины перетасовки экзонов". У кукурузы, например, выявлено около 20000 фрагментов разных

генов, которые были «перетасованы» с участием хелитрона (Liu et al., 2011; Thomas et al., 2010). Показано, что высоко гомологичные участки к нему сохраняются в геномах эукариотических организмов и, по-видимому, принимают участие в эволюции.

4. Заключение

Учитывая тот факт, что в геноме лошадей нуклеотидные последовательности занимают только около 2 % от количества нуклеотидов, а диспергированные повторы – более 40 %, очевидно, что использование для полилокусного генотипирования в качестве геномных «якорей» последовательностей транспозонов, позволяет охватить большую часть генома по сравнению генотипированием по микросателлитным локусам.

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Поколения молекулярно-генетических маркеров в исследованиях генетических структур лошадей

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Аннотация. Представлен обзор различных поколений молекулярно-генетических маркеров, применяемых для решения традиционных задач селекционной работы – исключения ошибок происхождения; выяснения путей распространения генетических потоков животных сельскохозяйственных видов; выявления генетических систем, полиморфизм которых ассоциирован с изменчивостью хозяйственно ценных признаков. Рассматривается история использования генотипических характеристик в качестве «сигналиев» для прогноза желательного проявления хозяйственно ценных признаков, начиная с работ А.С. Серебровского. Обсуждается необходимость последовательного изучения генофондов местных пород, обладающих уникальным потенциалом адаптации к действию конкретных эколого-географических факторов условий разведения животных. Отмечается общность молекулярно-генетических систем, вовлеченных в адаптацию, в частности, к высокогорной гипоксии, у таких видов млекопитающих, как домашняя лошадь и человек. В качестве примера адаптации к высокогорным условиям разведения

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обсуждаются особенности карачаевской лошади. Рассматриваются разные методы геномного сканирования (полилокусного генотипирования) с использованием в качестве геномных «якорей» случайно выбранных декануклеотидов (RAPD-PCR), последовательностей микросателлитных локусов (ISSR-PCR маркеры), ретротранспозонов (IRAP-PCR маркеры). Обсуждаются особенности представленности в геномах животных микросателлитных локусов, ДНК и РНК транспозонов.

Ключевые слова: молекулярно-генетические маркеры, группы крови, электрофоретические варианты белков, микросателлиты, транспозоны, эндогенные ретровирусы.

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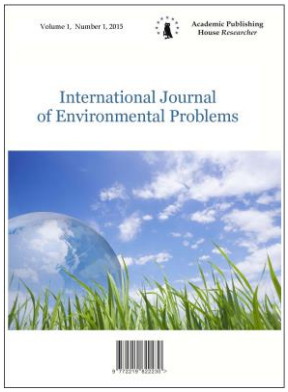

Application of GIS Technique for Mapping Suspended Sediment Concentration in Surface Water of the Day River, Northern Vietnam

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Abstract

Monitoring of suspended sediment is important to maintain water quality and geomorphologic balance. Traditional methods based on field surveys only solve the problem on a small scale. This article presents the results of mapping suspended sediment concentrations in surface water of the Day River, northern Vietnam using GIS technique. The inverse distance weighting (IDW) interpolation method was applied to map suspended sediment concentration using data obtained from 11 sampling stations. The results which are obtained in this study can be used to evaluate surface water quality.

Keywords: GIS, suspended sediment, interpolation, IDW, surface water, Vietnam.

1. Introduction

Suspended sediment has long been recognized as an important contaminant affecting surface water resources. Besides its direct role in determining water clarity, suspended sediment has the potential to transport chemical pollutants, including nutrients, trace metals and numerous pesticides into lotic systems. For the above reasons, monitoring suspended sediment in surface water is important. Traditional methods of data collection and analysis, including water sampling, filtering and measuring dry weight, are time consuming, labor intensive and provide only point data (Lodhi and Rundquist, 1998).

Geographical information system (GIS) is the most efficient tool for mapping the suspended particle concentrations and observing seasonal movements of turbidity in surface water. Spatial interpolation methods are frequently used to estimate values of physical or chemical constituents in locations where they are not measured. To monitor and map suspended sediment distribution, many researchers have determined the suspended sediment concentration and assessed water pollution by using spatial interpolation methods, such as Inverse distance weighted (IDW), Kriging, Spline, Trend, Natural Neighbor...methods (Meratnia et al, 2000; Bilhimer, 2012; Alaguraja et al, 2010; Narany et al, 2014; Nas, 2009; Tahoora Sheikhy Narany et al, 2014; Li et al, 2006).

This paper is focused on mapping suspended sediment distribution in surface water of the Day River, northern Vietnam using GIS technique based on IDW interpolation method and in situ data collected from five observations in March, May, July, September and November 2015.

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2. Materials and Method

2.1. Study area

The Day River is a large river and one of the five longest rivers in Northern Vietnam. The river is a distributary of the Red River, draining into the Gulf of Tonkin. The river has a length of 240 km and has a drainage basin of more than 7 500 km², flowing through 5 provinces (Figure 1). The study area was selected as the Day River through Ha Nam, Nam Dinh and Ninh Binh provinces.

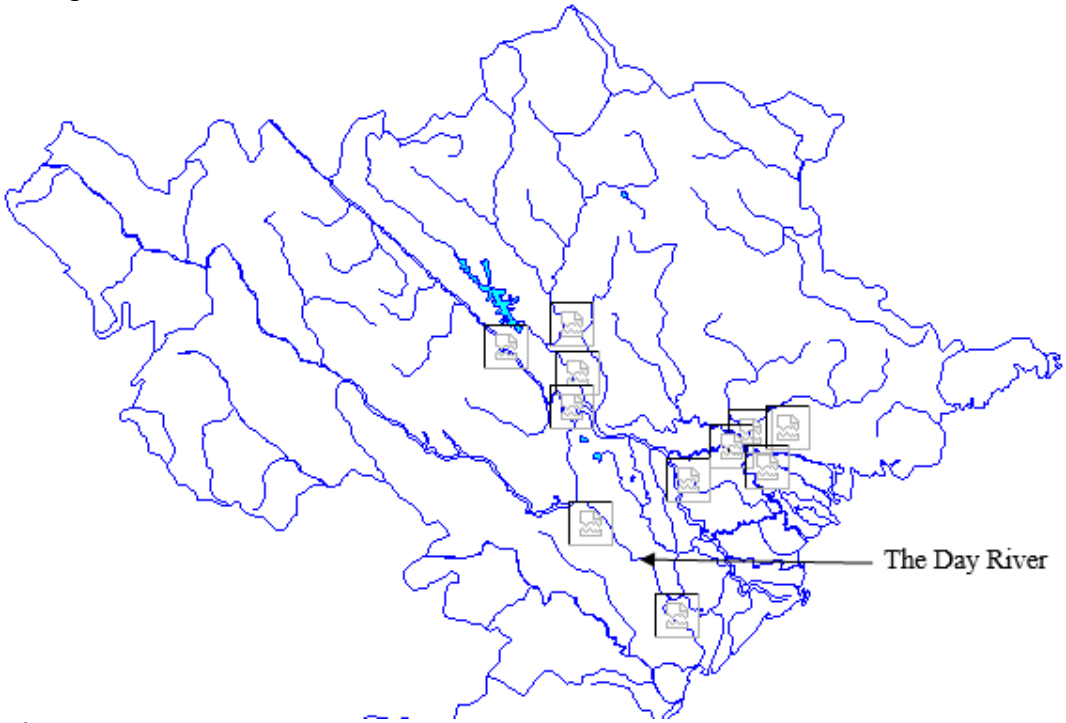


Fig. 1. Hydrologic map of northern Vietnam

2.2. Surface water sampling

A total of 11 field measurements of suspended sediment concentration were carried out in the Day River. All in situ data were collected during research cruises in March, May, July, September and November 2015 in a set of stations distributed along the Day River (Figure 1). In table 1, it can be seen that the highest concentrations of suspended sediment were found at the sampling stations No. 6, 7, 8, 9, 10 and 11 in March 2015, and at sampling stations No. 1, 2, 3, 4, and 5 in May 2015.

Table 1. In situ measurements of TSS in 2015

No.	Coordinates		TSS (mg/l)				
	Latitude	Longitude	March 2015	May 2015	July 2015	September 2015	November 2015
1	105°48.27'	20°36.47'	23	59.4	31	18	20
2	105°52.4'	20°34.2'	20	48.3	15	22	16
3	105°53.6'	20°34.1'	15	54.6	15	22	24
4	105°55.5'	20°31.4'	27	62.2	15	22	32
5	105°54.6'	20°30.5'	33	41.2	35	24	15
6	105°54.2'	20°26.4'	148	61.2	26	26	15
7	105°55.4'	20°22.4'	203	39.9	15	15	19
8	105°55.5'	20°22.8'	69	39.3	27	21	55
9	105°56.3'	20°19.5'	70	30	15	43	21
10	106°01.8'	20°14.8'	74	48.2	15	32	38
11	106°03.1'	20°15.1'	102	55	21	16	39

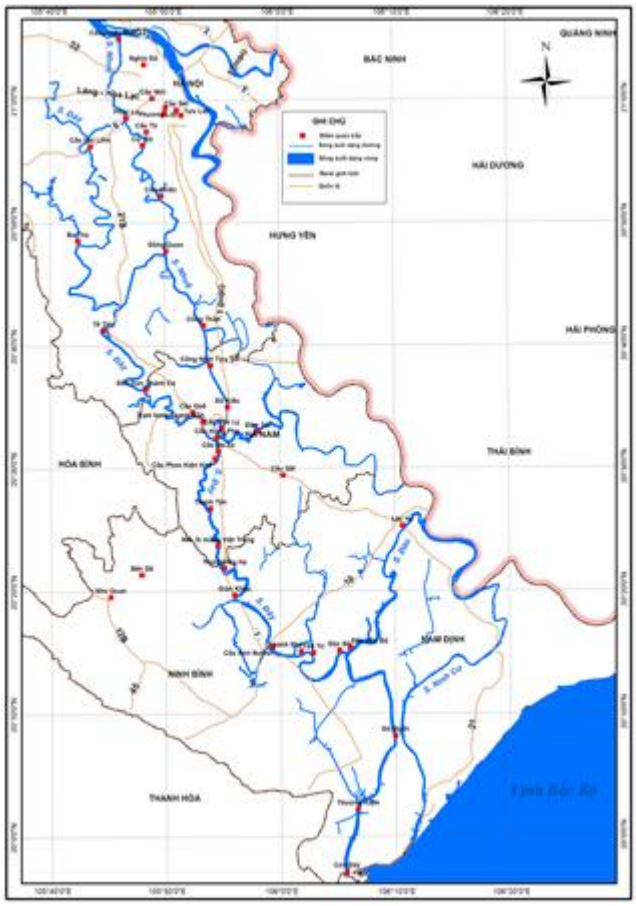


Fig. 2. Suspended sediment sampling locations in the Day River

2.3. Methodology

Four interpolation methods were evaluated, including Inverse Distance Weighting (IDW), Spline, Ordinary Kriging (OK) and Indicator Kriging (IK) for selecting the most efficient and accurate interpolation method for mapping of suspended sediment in surface water of the Day River. The interpolation method accuracy was evaluated on the basis of the root mean square error (RMSE) for cross-validation. In this study, the IDW interpolation method was selected due to the smallest root mean square error (RMSE).

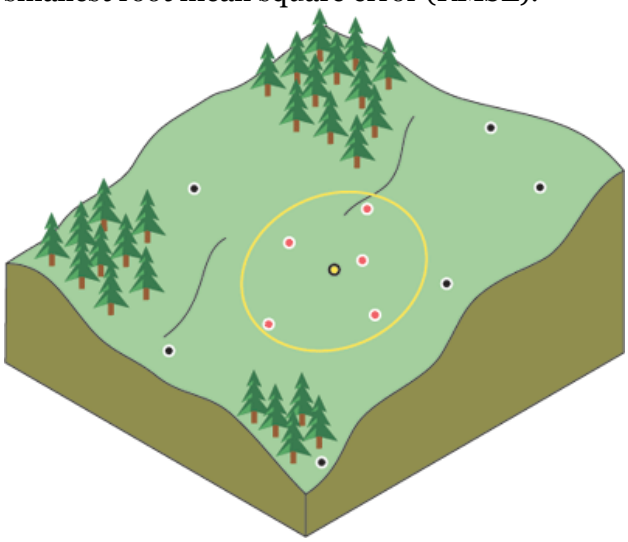


Fig. 3. IDW interpolation method (http://esri.com)

Inverse Distance Weighted (IDW) is a method of interpolation that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. The closer a point is to the center of the cell being estimated, the more influence, or weight, it has in the averaging process (http://esri.com).

3. Results and Discussion

In this study, the suspended sediment distribution map is prepared by employing an Inverse Distance Weightage *(*IDW) interpolation method in ArcGIS. The suspended sediment distribution maps area displays the different zone of suspended sediment concentration. The density sliced image shows five suspended sediment concentration zones that represents greater than 100, 50 – 100, 30 – 50, 20 – 30 and less than 20 mg/l respectively, in which areas of highest suspended sediment concentration colored in black. These maps were created using Vietnam National Technical Regulation on Surface Water Quality (QCVN 08-MT: 2015/BTNMT).

Table 2. National technical regulation on surface water quality (QCVN 08-MT: 2015/BTNMT)

No.	Parameter	Units	Limiting value of TSS			
			A		B	
			A1	A2	B1	B2
1	Total suspended sediment	mg/l	20	30	50	100

The classification of A1, A2, B1, B2 for surface water sources to assess and control water quality the various purposes of water use, sorted by descending quality level (National technical regulation on surface water quality (QCVN 08-MT: 2015/BTNMT)).

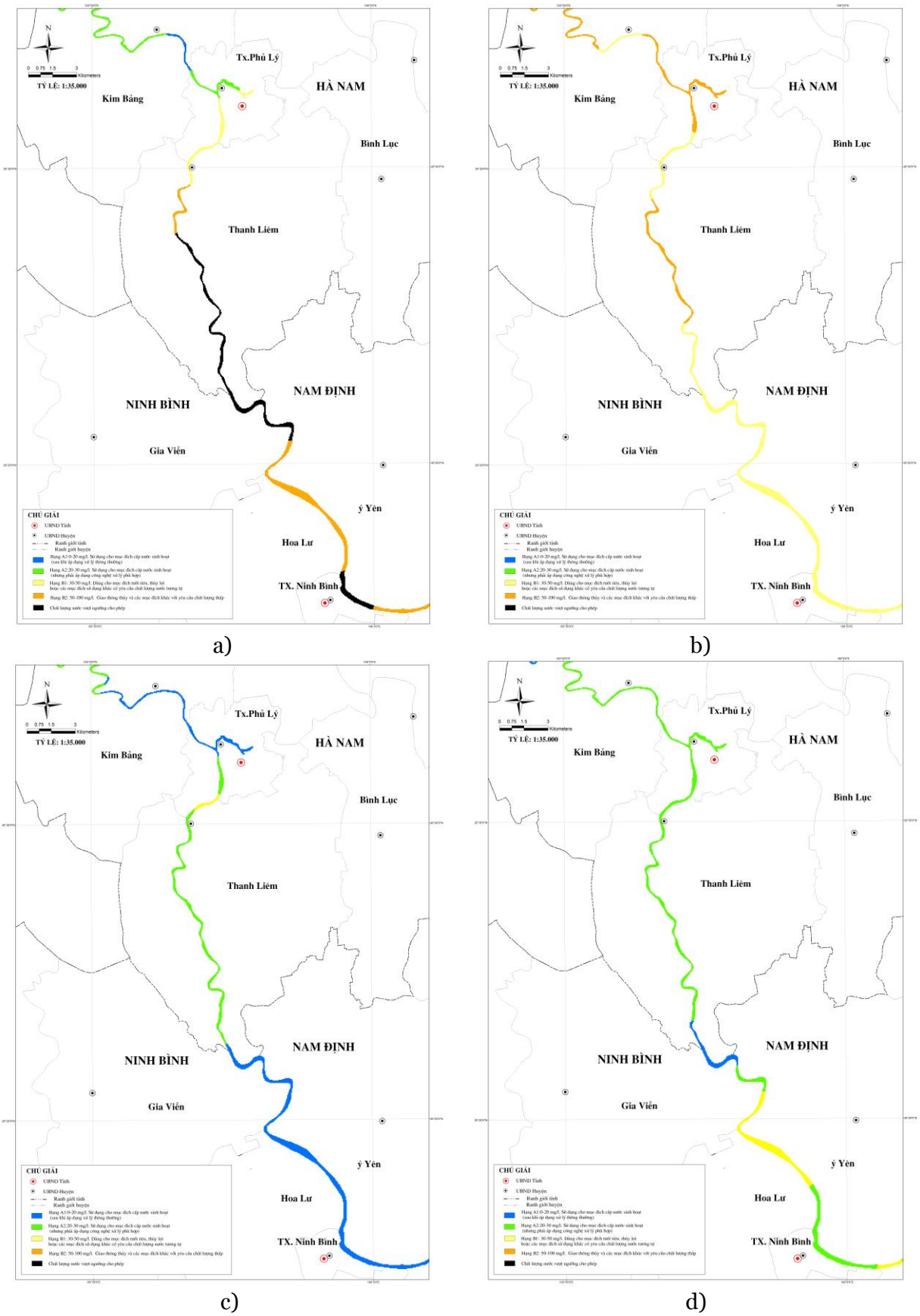
A1 – Use for domestic water supply purposes (after applying conventional treatment), conservation of aquatic plants and for other purposes such as type A2, B1 and B2.

A2 – For the purpose of domestic water supply, but must apply appropriate processing technology or the purpose of use as type B1 and B2.

B1 – For irrigated agriculture, irrigation purposes or other purposes which require the same water quality or purposes as type B2.

B2 – Waterway transport and other purposes with low quality water requirements.

Suspended sediment concentration maps in surface water of the Day River, northern Vietnam in March, May, July, September and November 2015 are shown in Figure 4 (a-e). The obtained results showed that surface water of the Day River has high concentration of suspended sediment at most of the sampling stations in first observation (March 2015), with concentration ranging from 15 to 203 mg/l, in which concentrations was higher 100 mg/l in many areas. The mean concentration of suspended sediment is 71.2 mg/l, 49.0 mg/l, 20.9 mg/l, 23.7 mg/l and 26.7 mg/l in observation in March, May, July, September and November 2015 respectively. This can be explained by surface water environment of the Day River basin are subjected to wastewater discharges from municipal, industrial and agricultural sources. The water quality of many segments of the Day River is heavily polluted, especially in the dry season. The concentration of suspended sediment at the measurement stations exceed Vietnam National Technical Regulation on Surface Water Quality (QCVN 08-MT: 2015/BTNMT) type A1 several times.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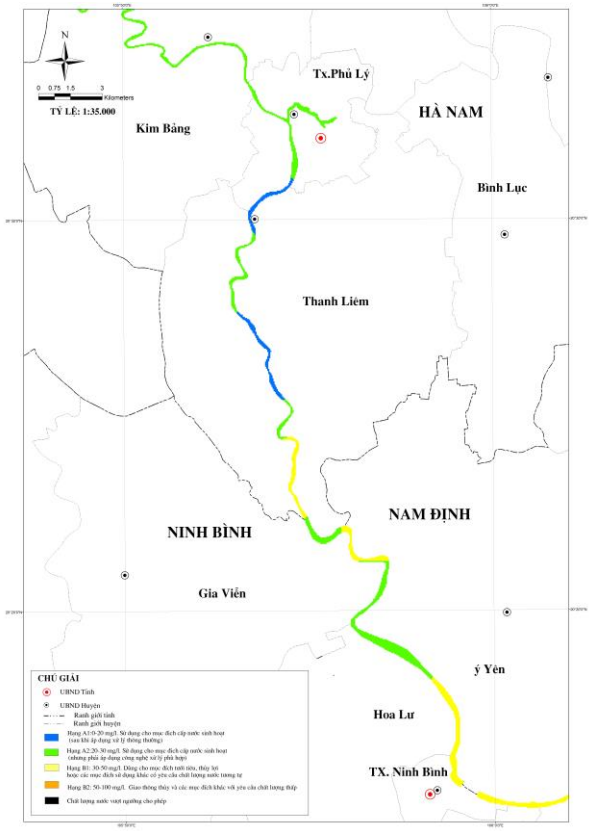
a) b)

c) d)



e)

Fig. 4. Spatial distribution of suspended sediment for the Day River in March (a), May (b), July (c), September (d) and November (e) 2015

4. Conclusion

Nowadays, surface water pollution has become a global issue, directly caused by human populations grow, industrial and agricultural activities and climate change. A simple and operational method is presented to map the suspended sediment concentration in surface water of river using GIS technique based on spatial interpolation method.

The obtained results show that, suspended sediment concentration in first and second observations (March and May 2015) in surface water of the Day River is much higher than Vietnam National Technical Regulation on Surface Water Quality (QCVN 08-MT: 2015/BTNMT). While, suspended sediment concentration decreased in other observation in July, September and November 2015. In these observations, surface water of the Day River can be used for domestic water supply purposes (after applying conventional treatment or appropriate processing technology).

The obtained results in this paper can be used for mapping suspended sediment concentration distribution, in particular and to serve surface water quality, in general.

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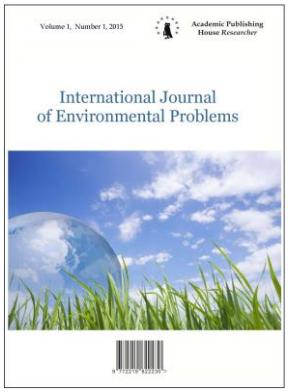

Application of Analytical Hierarchy Process (AHP) Technique to Evaluate the Combined Impact of Coal Mining on Land Use and Environment. A Case Study in the Ha Long City, Quang Ninh province, Vietnam

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Abstract

Coal mining is an important contributor to Vietnam's GDP, however, it also seriously effects on the environment. This study presents the results of impact assessment of coal mining on land use/land cover, water resources and urban landscape in Ha Long city, Quang Ninh province, North East of Vietnam. The study was conducted in the basis of an analysis of samples (12 soil samples, 5 surface water samples and 5 groundwater samples) and AHP hierarchical technique through a survey of 40 households, 30 managers and 30 technicians in the coal mining area. The results obtained in this study show that land use change in coal area of Ha Long city is proportional to annual coal production, in which agricultural land, residential land, river and stream water are the factors most affected by coal mining.

Keywords: coal mining, environment, land use, AHP, Vietnam.

1. Introduction

Mineral resources are one of the most important natural resources of each country. Minerals are the source material for many industries, such as energy production, building materials, metal, for agricultural, industrial.... Mineral mining is one of the most important economic activities in Vietnam, it also seriously affects the land cover, natural ecosystems, and human living environment at varying degrees. Ha Long City – the center of Quang Ninh province has big reserves of coal with over 530 million tons of coal and the potential for mining is huge. In recent years, environmental quality in Ha Long city is severely degraded. In fact, most of soil, water and air in coal area of Ha Long city has been infiltrated mixed in many different types of toxic, seriously affect the living environment (Ha Long City People's Committee, 2015). Up to now, there is no scientific research that has been fully evaluated about the impacts of coal mining activities in the coal mine area of Ha Long city. Therefore, the purpose of the study was to evaluate the impact of coal mining on the surrounding environment specifically on land cover/land use and water, to contribute to environmental improvement after mining and to optimize land use allocation for sustainable development.

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2. Materials and Method

The secondary data are collected at the Ha Long City People's Committee and some other related departments. These documents have been issued which related to natural and socio-economic conditions, coal mining activities and the impacts of coal mining on land use, landscape and water resources in Ha Long area.

Besides, this study examined the comments of local people (40 votes), management staff (30 votes) and technical staff of enterprises in Ha Long coal mine (30 votes) about the impact of coal mining on land use/land cover.

The study was conducted on the basis of an analysis of samples (12 soil samples, 5 surface water samples and 5 groundwater samples). Samples were collected during the survey in March 2015. Sampling sites were selected at the Nam Lo Phong waste disposal sites, surrounding area of coal mining sites, coastal areas and areas with tourist activities.

Finally, analytical hierarchy process (AHP) method was used to evaluate the impact of coal mining on soil quality and land use, water quality and landscape (Figure 1). The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. Created by Thomas L. Saaty in the 1970s, this method consists in the development of a model that reflects the workings of the human mind in the evaluation of the alternatives facing a complex decision problem. Up to now, this method has been widely applied in many fields such as land use, geology, environment, agriculture, economy and military (Adi Setiawan, 2014; Cengiz, 2009; Le Canh Dinh, Tran Trong Duc, 2011).

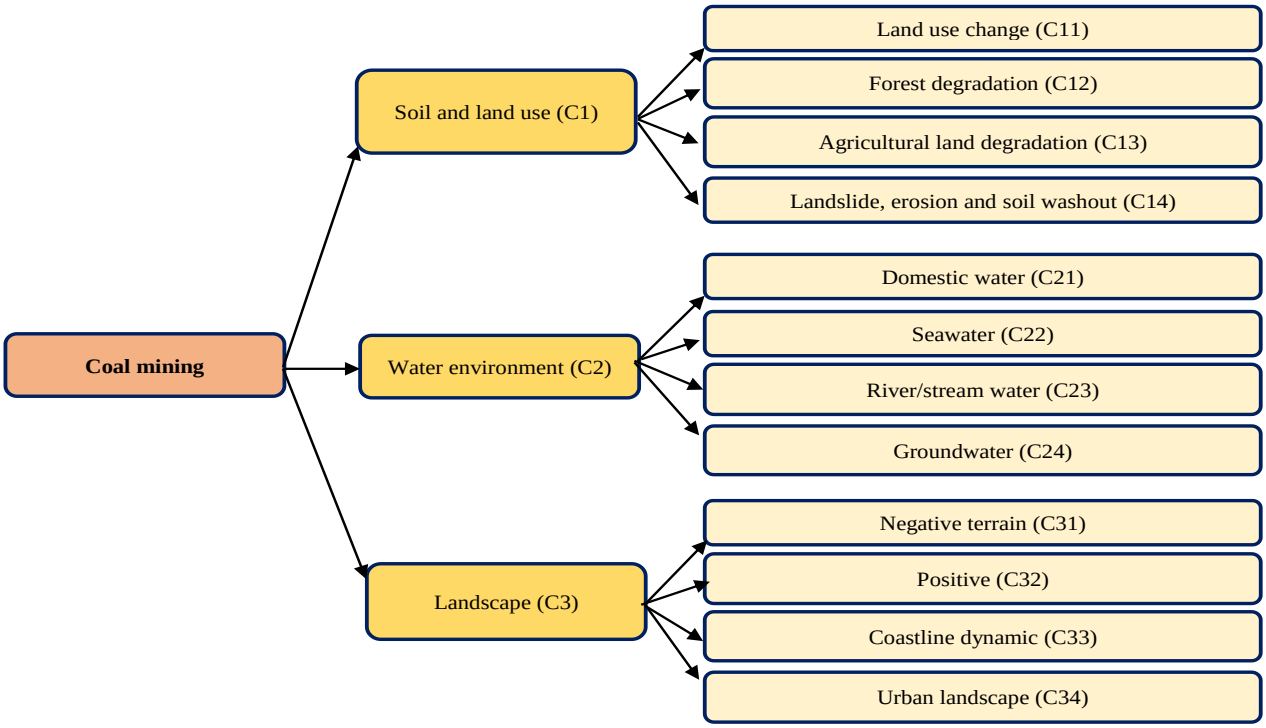

Fig. 1. The variables used in AHP model

3. Results and Discussion

There are numerous damaging environmental impacts of coal that occur through its mining, preparation, combustion, waste storage, and transport. The results of the component impact assessment show that coal mining has the strongest impact to the agricultural and residential land, water resources and landscape. Therefore, the combined impact assessment of coal mining activities in coal area of the Ha Long city is based on three groups: land use, water resources and landscape (Figure 1).

a) Pairwise comparison (Saaty's AHP) amd calculating the AHP weight (order = 1) (factors affected)

The results of the AHP calculations show that land use (w = 0.79) was the most strongly affected by

coal mining. Water resources (w = 0.13) and landscapes (w = 0.08) are secondary and tertiary factors, which affected by coal mining. The CI value (<0.01) reflects the rationality in the calculation (Table 1).

Table 1. Pairwise comparison (Saaty's AHP) and the weight of impact of coal mining on environment (Saaty's matrix of order 1)

Factor	Variable	C1	C2	C3	Weight (Wi)	Level of impact
Land use	C1	1	4	7	0,79	1
Water resources	C2	1/4	1	3	0,13	2
Landscape	C3	1/7	1/3	1	0,08	3

The weight values of AHP are verified by comment of people using survey votes. The results show that land resources and land use are the most strongly affected by coal mining (40/40 votes), water resources is secondary (38/40) and landscape (25/40) is tertiary affected by coal mining (Table 2).

Table 2. Summary of survey result of impact of coal mining on the environment

Factor	Number of votes	Rate of votes (%)
Land use	40/40	100
Water resources	38/40	95
Landscape	25/40	62,5

b) Pairwise comparison (Saaty's AHP) amd calculating the AHP weight (order = 2)

After determination of the impact of coal mining activities on the factors of matrix of order 1, this study assesses the level of impact in each major level.

The first is the impact on agricultural land and residential land. This group has four components which are determined to be most affected by coal mining: forest appropriation, forest degradation, waste rock and landslide.

If CI value less than 0.1, then the calculation result is accepted. It can be seen that the weight of landslide factor is highest (w = 0.54), that is the coal mining activities have the strongest impact on the removal of rock material on the surface of the mining area. This not only affects mining operations but also affect the environment and landscape of coal mining activities. Soil pollution due to waste rock has the second highest weight value (w=0.31). The impact of these two factors is not as strong as that of waste rock and landslides (w = 0.17 and 0.13).

Pollution from coal mining may have a negative impact on surface water and groundwater. The results obtained show that the impact of coal mining on river and stream water resources is strongest (w=0.53). Groundwater (w=0,31), sea water (w=0,11) and domestic water (w=0,05) are less affected from coal mining activities.

Table 3. Pairwise comparison (Saaty's AHP) and the weight of impact of coal mining on land use (Saaty's matrix of order 2)

Factor	Variable	Forest appropriation (C_{11})	Forest degradation (C_{12})	Waste rock (C_{13})	Landslide (C_{14})	Weight W(i)	Level
Forest appropriation	C_{11}	1,00	2,00	0,25	0,17	0,09	3
Forest degradation	C_{12}	0,50	1,00	0,20	0,13	0,06	4
Waste rock	C_{13}	4,00	5,00	1,00	0,50	0,31	2
Landslide	C_{14}	6,00	8,00	2,00	1,00	0,54	1
Total		11,50	16,00	3,45	1,79	1,00	

(CI = 0,01)

Table 4. Pairwise comparison (Saaty's AHP) and the weight of impact of coal mining on water resources (Saaty's matrix of order 2)

Factor	Variable	Domestic water (C_{21})	Sea water (C_{22})	River/stream water (C_{23})	Groundwater (C_{24})	Weight W(i)	Level
Domestic water	C_{21}	1,00	0,33	0,13	0,17	0,05	4
Sea water	C_{22}	3,00	1,00	0,20	0,25	0,11	3
River/stream water	C_{23}	8,00	4,00	1,00	3,00	0,53	1
Groundwater	C_{24}	5,00	6,00	0,33	1,00	0,31	2
Total		11,50	16,00	3,45	1,79	1,00	

(CI =0,08)

Coal mining has also affected the landscape, in which urban landscape is the most affected by coal mining activities (w = 0.5). Meanwhile, the coastline change is not much affected by coal mining (w = 0.07).

Table 5. Pairwise comparison (Saaty's AHP) and the weight of impact of coal mining on landscape (Saaty's matrix of order 2)

Factor	**Variable**	**Negative terrain (C_{31})**	**Positive terrain (C_{32})**	**Coastline dynamic (C_{33})**	**Urban landscape (C_{34})**	**Weight W(i)**	**Level**
Negative terrain	C_{31}	1,00	0,33	2,00	0,25	0,12	3
Positive terrain	C_{32}	3,00	1,00	5,00	0,50	0,31	2
Coastline dynamic	C_{33}	0,50	0,20	1,00	0,17	0,07	4
Urban landscape	C_{34}	4,00	2,00	6,00	1,00	0,50	1
Total		8,50	3,53	14,00	1,92	1,00	

(CI = 0,01)

To verify the results obtained by application of AHP technique for assessing the impact of coal mining activities on environment and land use/land cover, in this study we use the information collected through the social survey. The questionnaire was designed with 7 questions, the respondents are the people who live in areas directly and indirectly affected by coal mining (40 questionnaires in Ha Tu, Ha Lam and Ha Khanh wards). The results which obtained show that all questionnaires were selected that "coal mining causes landslides" in coal area of Ha Long city. Most questionnaires were selected that "coal mining causes soil pollution and forest degradation". Finally, the factors that most people consider least affected by coal mining activities are domestic water (15/40 votes), negative terrain (15/40 votes), positive terrain (15/40 votes) and coastline change (10/40 votes).

4. Conclusion

Based on this study, it shows that coal mining has a great impact on natural resources and environment in Ha Long city, Quang Ninh province, especially for land use, water resources and urban landscape. Land use change in Ha Long city is proportional to coal production. Soil erosion and landslide not only affected the quality of soil, but also threatening the resilience and the plan for reverting and reusing in coal mining areas. Waste disposal sites in study area (Nam Lo Phong, Chinh Bac, Ha Tu…) were located near residential areas, coastlines, upstream and seriously affecting the water quality.

The results obtained in this paper can be used to assess the impact of coal mining on natural resources and the environment and to help managers to take measures to minimize these negative effects.

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