A PROPOSAL FOR A NEW METHODOLOGY IN ECONOMIC QUANTIFICATION OF DISASTERS

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Abstract

Each country bears the primary responsibility for protecting its people, infrastructure and other national assets from the impact of disasters and for taking steps to reduce the vulnerability of populations in areas at risk. Government and other institutions are willing to set up and develop new and different measures, strategies and programs with this aim. Research is required to develop a comprehensive and uniform methodology for evaluating the socio-economic effects of disasters to assist decision making.

The evaluation and quantification of the economic consequences of a disaster are usually divided into the pre-disaster and post-disaster phases. While the traditional disaster evaluation is focused on post-disaster effects, the preparedness and mitigation measures must be necessarily accounted as a disaster cost, or more specifically as a reduction in the post disaster cost. The traditional evaluation is carried out during the emergency phase. But it is not easy to obtain all the information needed to evaluate the magnitude of direct damage, still less the indirect and secondary effects. It is absolutely essential to identify and quantify its effects as accurately as possible. The main objective of this paper is to propose a comprehensive and uniform methodology for evaluating the socio-economic effects of disasters as a tool for assisting decision making regarding the direction and priorities for rehabilitation, recovery and reconstruction plans and programs.

1. Introduction

All countries around the world have suffered a large loss of human life and heavy physical and economic damage as a result of natural, technological and human disasters. The impact on living conditions and national economies is related with their economic performance and the long term sustainability of their development strategies, economic policy, and the country's stage of development. In industrialized countries, tremendous losses are sustained to the capital

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stock, while losses of life are usually very low because there are effective forecasting and warning systems. In developing countries, disasters always result in heavy loss of life because there are poorly resources and trained organization, prevention and evacuation systems. The impact on economic development is usually considerable, although capital stock losses may be less.

Based on statistics and additional estimates of Munich Re Group, just during the year 1999 natural disasters cost European countries more than 800 lives and over 18,000 million US$ in economic losses. Taking in consideration 1999 data (Munich Re Group, 2000), some of the most significant European loss events are, for example:

- January: more than 10,000 avalanches in the Alps (Switzerland, Austria, Germany and Italy) caused 108 fatalities and more than 850 million US$ economic losses. Hundreds of houses were buried, the forest was seriously damaged, entire regions cut off from the outside world. Tourism was badly affected.
- January: the Canary Islands suffered a winter gale with wind speeds of 100 km/h, and waves of 6 meters high. There was more than 415 million US$ losses in damages to harbours, yachts, houses, fish farms, agriculture and infrastructure.
- May: floods in Switzerland, Germany and Austria, with 13 fatalities and more than 750 million US$ losses.
- August: a 7.4 Mw. earthquake in Turkey, with more than 17,200 fatalities, 44,000 injured, 600,000 homeless. More than 270,000 houses and business damaged or destroyed and more than 12,000 million US$ economic losses.
- September: a 5.9 Mw. earthquake in Greece with 138 fatalities and more than 4,150 million US$ economic losses.
- December: winter gales in France, Switzerland, Germany and Spain. More than 130 fatalities and more than 11,000 million US$ economic losses.

European countries are included in the group of countries with the highest gross national product (GNP) per capita. Some studies made over the final years of the 20th century indicates the following results (Munich Re Group, 2002):

- ✓ the countries with the highest frequency of natural catastrophes are the rich countries;
- ✓ the countries with a high per-capita income come off much lighter about of loss of life;
- ✓ the rich countries bear the main economic losses in absolute terms.

The economic losses in the developed countries (groups 1 and 2 of the World Bank classification) affect to a large proportion of the population, generally the lower-income population, and is a mayor setback for governments´ development efforts (World Conference of Natural Disaster Reduction, 1994).

Each country bears the primary responsibility for protecting its people, infrastructure and other national assets from the impact of disasters and for taking steps to reduce the vulnerability of populations in areas at risk. For these and other reasons, government and other institutions are willing to set up and develop new and different measures, strategies and programs with this aim and also the development of infrastructure, institutional strengthening as well as the improving of the economic and financial efficiency (Drabek, T.E. and Hoetmer, G.J., 1991).

This paper has the aim to look for a uniform and comprehensive methodology for the quantification of the economic effects of a disaster in the European Union framework with two priorities:

1.- the methodology should allow the decision making about disaster prevention, mitigation and preparedness measures as well as rehabilitation and reconstruction programs;

2.- the methodology should be important as a tool for the adoption of decisions on the direction and priorities about geographical and sectorial investments.

2. Project definition

The long term aim of this project is to assist individuals and institutions involved in the identification and quantification of damage caused by natural and technological disaster, by providing a uniform and coherent methodology. As a result of this work, government and institutions will provide information needed to identify the social or economic sectors or geographical regions which must have the priority in the rehabilitation and reconstruction process (Brooks, D.G. and Borison, A., 1998).

The evaluation and quantification of the economic consequences of a disaster must be divided into two temporary phases: pre-disaster and post-disaster phases. While the traditional disaster evaluation is focused on post-disaster effects, the preparedness and mitigation measures must be necessarily accounted as a disaster cost, or more specifically as a reduction in the post disaster cost. The post disaster period is usually divided in three phases:

A.- the emergency and response phase;
B.- the rehabilitation and recovery phase; and
C.- the reconstruction phase.

When a disaster occurs, along with the first emergency measures taken by the government and the community impacted, various national and international agencies offer relief, aid and assistance. This support is very important, but only represents part of the total cost of the necessary process of post disaster recovery. For this reason, one of the most important tasks for the country concerned is to make an early, reliable preliminary assessment of damage. The traditional evaluation is carried out during the emergency phase. However, it is not easy to obtain the information needed to evaluate the magnitude of the direct damage, still less the indirect and secondary effects. It is absolutely essential to identify and quantify its effects as accurately as possible, although is also necessary to wait until the first emergency activities are complete so as not to interfere with relief efforts. It is important not to wait to long because the result of evaluation is needed for designing rehabilitation and reconstruction programs and for identify how international cooperation have to be channeled.

3. Project phases

The main objective of this project is to look for a comprehensive and uniform methodology for evaluating the socio-economic effects of disasters as a tool for the adoption of decisions on the direction and priorities of rehabilitation, recovery and reconstruction plans and programs. The proposed methodology's three main steps are:

1. The art state of studies and research
2. Damage assessment
3. Simulation and modeling

FIRST STEP: The art state of studies and researches

The first step for developing a uniform methodology for quantification of economic effects of natural and technological disasters is to compile and systematize the experience gained by governments as well as for professional and other non-governmental organizations, particularly scientific and technological societies, humanitarian groups and investment institutions. Actual and ongoing researches within the European Union and other international Organizations (Geominig Technological Institute of Spain, 1995) must be evaluated and considered in order to decide about the variables and analyzers of the economic effects of catastrophe as well as to extend a uniform methodology.

The suggested methodology for this step is:

- to compile and systematize the experience and researches;

- The comparison of available information; and
- Data analysis.

SECOND STEP: Damage assessment

The evaluation of natural and technological disaster should not only have in consideration immediately perceptible effects, such as those caused by earthquakes, fires or floods. They also have to include consequences that develop slowly or appear only long after the event. One of the classifications of the natural and technological disaster effects divides them into direct damage (effects on property), indirect damage (effects on production flow of good and services), and secondary effects (effects on the behavior of the main macroeconomic aggregates) (Economic Commission for Latin America and the Caribbean, 1999). The first set of damage coincides with the immediate disaster while the other two effects occur within hours of it or over a period of time between two and five years depending on the magnitude of the disaster. This classification allows a full assessment of the disaster's socio-economic impact at the time it occurs, and also of its subsequent effects.

To facilitate understanding of the variables and analyzers it is interesting to describe the kind of damage to be included in each of these three categories of effects:

i) DIRECT DAMAGE

Direct damage refers to physical destruction, that occurs simultaneously or immediately after the disaster and is related to fixed assets, capital and inventories of finished and semi-finished goods, raw materials, and spare parts. It includes total or partial destruction on immovable assets and inventories such as physical infrastructure, buildings, machinery and equipment, furniture, transport and storage facilities, damage to farmland and soils, irrigation and drainage works, dams, crops ready to harvest, etc.

The estimated cost of demolish and clearing areas where there has been destruction and the cost of the emergency response or, in some cases, the preparedness and mitigation costs should be considered and accounted as direct damage (Comision Económica para America Latina y el Caribe, 1999).

ii) INDIRECT DAMAGE

Indirect damage refers to damage to the flow of goods that will not be produced and of services that will not be provided after the disaster strikes. The period of quantification begin immediately after the disaster and run over months or years depending on the type and characteristics of the disaster.

Indirect damages are measured in monetary terms and may include, at least, the following kinds (Nacional Academy of Sciences, 1999):

- increased operational expenditures in a given sector due to the destruction of physical infrastructure or inventories, and increased costs for the provision of services;
- additional costs incurred in a given sector or activity due to the need to use alternative ways of production or for the provision of a service;
- losses of income as a result of the non-provision of services in utilities and losses of personal income in the case of individuals losing their way of live;
- unexpected expenditures related to meeting "new" needs arising from the disaster;
- production or income losses caused by a "chain" reaction similar to that occurring in a recession;
- investments incurred to respond to the need to relocate fixed assets or activities to safer areas after a disaster (Mascareñas, J., 2002); etc.

iii) SECONDARY EFFECTS

Secondary effects refer to the impact of the disaster on the overall economic performance of a country measured through the most significant macroeconomic variables. The estimation of changes in these variables due to the disaster is already measured by direct and indirect damages, but is necessary this different point of view because they can not be mathematically added to express the total amount of damage (Oficina del Coordinador de las Naciones Unidas para el Socorro en Casos de Desastre, 1979)

A disaster's main secondary effects are those which have an impact on:

a) The overall and sectorial **gross domestic product** (GDP).
Gross domestic product can be reduced by the anticipated decline in the output of sectors that sustained direct and indirect damages; it can also grow due to the surge in the construction sector as a result of rehabilitation and reconstruction activities;

b) The **balance of trade** and the **balance of payments**.
The balance of trade and the balance of payments can be affected due to export shrinkage resulting from diminished output, and by increased import requirements to face internal demands and the requirements of rehabilitation and reconstruction;

c) The **level of indebtedness and of monetary reserves**.
Reconstruction efforts may involve acquiring or increasing foreign or local indebtedness; depending on the economic position of the country prior to the disaster and if the secondary effects are sufficiently large, it is possible that the country's international reserves and its ability to meet external commitments can be jeopardized.

d) The state of **public finances**.
Public sector spending grows to meet the needs of the emergency and rehabilitation phases and tax revenues may shrink because of reduced output and diminished exports, which may combine to create or increase fiscal budget deficits;

e) The amount of **gross capital investment**.

f) **Inflation**.
Prices may go up because of shortages or speculation, thus creating or worsening inflationary pressures on the economy;

g) **Employment levels**, and

h) **Household income**.

THIRD STEP: Simulation and modeling

This step will establish a comprehensive and uniform methodology for quantification of economic effects of natural and technological disasters with the priorities previously established. After the exhaustive compilation of quantitative information and their systematization held in the first step, and the second step focused on post disaster damage assessment, the project is ready to develop their third step: the election for the best objectives adapted methodology or methodologies.

The choice of the best methodology or methodologies that quantifies the postulated economic effects of catastrophes for decision making regarding prevention and mitigation strategies as well as recovery measures should include factors that limit the available options (Martinez Torre-Enciso, Mª.I. and Laye, J.E., 2001):

1) The first factor is the pre-disaster socioeconomic condition. It is very important to distinguish between developed and underdeveloped countries. The economic and social differences of those country groups get very different disaster impact and respond capacity. The available information data and their sources are also very different. Within the developed countries there are regional and national differences that must be considered.
2) The second factor is a temporal limitation. It is essential to designate the post disaster study period, because the impact in some macroeconomic variables require a long time

for measurement. Also remember that indicators and other data related to a disaster will be delayed in publication.

3) The third limitation is the geographical factor. If the analysis is too narrow in focus (i.e., local or regional) there will be problems in the quantification: on one hand, information, data and statistic for such disaggregation levels might not be available. On the other hand the local or regional level disaster might not be important at all at the national level. Problems also could arise if the focus is too extensive, i.e., more that national level because they are not so aggregated available data.

Taking into account all those limitation decision makers could use different methodologies for the quantification of the economic effects of a catastrophe in the European context. Some of those methodologies are: Input-Output impact models (IOT) (NIBS, 1997), macroeconomic analyzers (gross domestic product, employment levels, etc.), cost-benefit analysis, computable general equilibrium models (Brookshire, D.S. and McKee, M., 1992; Boisevert, R., 1995), simultaneous equation econometric models (West, C.T. and Lenze, D.C., 1994), etc. Almost all of those methodologies allow simulations to study and to compare the economic situation in different time periods. Those simulations would be possible depending on the data available and the aim of the process.

4. A methodological proposal for the quantification of the economic effects of a catastrophe in Europe

The proposed methodologies for the quantification of the economic effect of catastrophes need a temporal development that should be studied within three phases:

1) First phase: predisaster situation

This phase is focuses in the description of the studied area in order to identify possible limitations or problems and the possibility to obtain an idea of the economic situation as short as possible to the catastrophe date. This is an ex ante approach that require a modeling methodology that permits forecasting or simulation of losses. The analysis should be geographical and temporal limited in order to establish a framework to relate the main social, economic and political characteristics (public intervention, emergency preparedness, etc.) in a predisaster situation.

This paper proposes three complementary methodologies that could be used for the quantification of mitigation and preparedness in the predisaster situation depending of the information available and its validity.

a) The first of the three methodologies to describe the predisaster economic situation are the Input-Output impact models (IOT) (Cochrane, H., 1997). Those tables show a quantitative vision of the interdependency of the different economic sectors and the magnitudes that represent them.

   This methodology has some advantages (World Meteorological Organization, 1996): first, all European countries have accurate and uniform data as well as the IOT; second, because of the use of uniform data the analyzers and indicators are comparable; third, from the accounting point of view this is a statistical data methodology that work with aggregate activity sectors and quantifies the relations and flows between them (internal consumption); fourth it documents and explains the production of each activity sector and their proportion on the final demand (consumption, capital, exports, etc.) and the use of essential factors (capital and work). The IOT offers a quantitative expression of the internal flows between the different activity sectors - a quantification that is not provided any other accounting methodologies.

b) The second methodology this paper proposes is the use of Computable General Equilibrium models, based on National Accounting, that aggregates the economic information into

accounts, by sectors or activities, showing the different parts of the productivity process. This allows a deeper analysis as well a completion of the information given by IOT.

c) The third methodology proposed aggregates a group of complementary indicators about prices, employment, etc., that provide information not included in the other to methodologies.

2) Second phase: damage assessment on response phase

To be able to make decisions regarding to the priorities of response and to the recovery strategies and rehabilitation it is essential to carry out a correct and quick balance of the damages caused by the catastrophe, as well as its immediate consequences keeping in mind the possible indirect and secondary effects that can take place on the affected area, i.e., the country or countries affected. This is a micro-economic valuation using fundamentally Computable General Equilibrium models (accounting). This valuation will establish priorities to assist the affected population and their more immediate and basic necessities. At that point, it is useful to use the traditional classification of the catastrophe effects, that divide them in three groups: direct effects (on the patrimony), indirect effects (consequences in the flows of goods and services) and secondary or induced effects (behavior of the macroeconomic indicators) (McEntire, D., 2002).

This second phase is focused in the valuation of the effects of a catastrophe in the emergency phase and response phase mainly to value the direct effects (destruction of infrastructures, interruption in the supply of the water, loss of human lives...) and leaving the valuation of the other two effects for the third phase.

3) Third phase: post-catastrophe macroeconomic valuation (half term)

This is probably the most important phase in the whole process since it is designed to know or estimate in a very approximate way, the macroeconomic effects that the catastrophe has taken not only in the country or affected region but perhaps also in the whole European Union. Given the levels of integration and globalization, any impact on financial, commercial shock, etc., may spread quickly to the whole frame of the European Union.

The methodologies that evaluate the economic effects of catastrophes in this third phase are the same methodologies suggested in the first phase: the IOT, the computable general equilibrium models and the macroeconomic indicators. The three proposed methodologies are complementary in function of the necessities and the readiness of information, and they will be used in function of the depth that is wanted for the analysis.

The really important thing in this phase is to be able to carry out a comparative analysis among the different methodologies pre and post catastrophe, being in fact the variation in the different methodologies that provides the total cost of the disaster. Also, the proposed process carries out simulations among the different activity sectors and identifies implications that causes change in the rest of the economy.

5. Conclusion

The proposed methodology is based on the Input-Output Tables, the National Accounting and the macroeconomic indicators; it fulfills the marked objectives for this work. The slected methodologies have as important advantages:

- the existence of homogeneous and harmonized data in the whole UE;
- it is a simulation model and projection that it provides an analysis of the incidence of certain alterations of prices, final demands, production, capital, etc.;
- it evaluates the alteration of the commercial and financial relationships with the rest of the world.

For all that the paper indicates we believe that a combination of Input-Output Tables, the National Accounting and the macroeconomic indicators would provide a comprehensive and uniform set of methodologies for the European frame that would allow decision makers to evaluate the economic effects of the disasters in a reliable way for the adoption of decisions about rehabilitation, recovery and reconstruction programs, as well as the establishment of geographical or sectored priorities for investment.

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