Disaster assessment methodology **exercise guide**

UNITED NATIONS

ECLAC

70 ECLAC FOR SUSTAINABLE DEVELOPMENT WITH EQUALITY

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Thank you for your interest in this ECLAC publication

Please register if you would like to receive information on our editorial products and activities. When you register, you may specify your particular areas of interest and you will gain access to our products in other formats.

Register

UNITED NATIONS

ECLAC

FOR SUSTAINABLE DEVELOPMENT WITH EQUALITY

www.cepal.org/en/suscripciones

facebook.com/publicacionesdelacepal

Project Documents

Disaster assessment methodology exercise guide

Economic Commission for Latin America and the Caribbean (ECLAC)

The general coordinator of this guide was Omar D. Bello, Coordinator of the Sustainable Development and Disaster Unit of the Economic Commission for Latin America and the Caribbean (ECLAC) subregional headquarters for the Caribbean, with support from Leda Peralta Quesada, Associate Environment Affairs Officer; Luciana Fontes de Meira, Associate Environment Affairs Officer; Alejandro Bustamante, Programme Assistant of the Latin American and Caribbean Institute for Economic and Social Planning (ILPES); Paulina Pizarro, ILPES Research Assistant; and Robert Williams. The assistance of Maricruz Flores of Peru's National Centre for Disaster Risk Assessment, Prevention and Reduction (CENEPRED) and of Francisco Ibarra and José Rodríguez, who reviewed and commented on the guide, is gratefully acknowledged.

The authors of the exercises are: Omar Bello (exercises 2, 3, 9 and 12), Leda Peralta (exercises 1, 4, 5 and 6), Robert Williams (exercise 7), Maricruz Flores and José Rodríguez (exercises 8 and 11) and Francisco Ibarra (exercise 10).

ECLAC is grateful to the German Agency for International Cooperation (GIZ) for the financial contribution it made to the printing of this handbook under the auspices of the German Federal Ministry of Economic Cooperation and Development (BMZ).

The views expressed in this document, which has been reproduced without formal editing, are those of the authors and do not necessarily reflect the views of the Organization.

United Nations publication
LC/TS.2018/64
Distribution: L
Original: Spanish
Copyright © United Nations, 2018
All rights reserved
Printed at United Nations, Santiago
S.18-00563

Applications for authorization to reproduce this work in whole or in part should be sent to the Economic Commission for Latin America and the Caribbean (ECLAC), Publications and Web Services Division, publicaciones.cepal@un.org. Member States and their governmental institutions may reproduce this work without prior authorization, but are requested to mention the source and to inform ECLAC of such reproduction.

Contents

Introduction

Disaster risk management planning and the methodology of disaster assessment in the context of the 2030 Agenda and the Sustainable Development Goals

The 2030 Agenda for Sustainable Development establishes a results framework consisting of 17 Sustainable Development Goals (SDGs), 169 targets and 232 indicators. The 2030 Agenda is **universal**, since the benefits of development must be for all and it is the responsibility of all countries to secure them; **indivisible**, with countries urged to approach the 17 Goals as a single whole, avoiding fragmentation; **integrated**, since it conjoins all three dimensions (the economic, the social and the environmental) of development; **civilizing**, since it proposes to eradicate extreme poverty as an ethical imperative, placing human dignity and equality front and centre; and **transformative**, as it calls for alternative approaches to "business as usual" in the interests of attaining sustainable development. Equality of rights and gender are omnipresent in the Agenda, and the multi-actor approach is essential to its ownership and implementation.

Planning is a means of implementation for attaining the SDGs. United Nations General Assembly Resolution 70/1, styled "Transforming our world: the 2030 Agenda for Sustainable Development", which brought the Agenda into being, makes special mention of the role of planning and the process whereby this commitment is to be adapted to national situations:

> "Targets are defined as aspirational and global, with each Government setting its own national targets guided by the global level of ambition but taking into account national circumstances. Each Government will also decide how these aspirational and global targets should be incorporated into national planning processes, policies and strategies" (para. 55).
>
> "We encourage all Member States to develop as soon as practicable ambitious national responses to the overall implementation of this Agenda. These can support the transition to the Sustainable Development Goals and build on existing planning instruments, such as national development and sustainable development strategies, as appropriate" (para. 78).

The countries of the region began to take ownership of the 2030 Agenda process early on by conducting reviews of the linkages between the SDGs and their national development plans and by setting up the institutional structures that were to lead implementation and follow-up.[1] There have also been exercises to increase knowledge and awareness of the 2030 Agenda and the SDGs.

In the process to date, over half the region's countries have put in place national coordination mechanisms for implementation and follow-up of the 2030 Agenda at the national level. Of these mechanisms, most have designated the planning authority as the coordinating or technical body. These mechanisms face the challenge of coordinating sectors, rallying actors and deciding on strategies and partnerships for SDG attainment, monitoring and accountability.

This shows how essential planning is for implementing the 2030 Agenda process. The planning authorities have a crucial leadership role to play in coordinating policies aimed at fulfilling the 2030 Agenda. They are the right institutions to pursue a long-term vision and reconcile it with the short and medium term. They are also responsible for coordinating different scales and sectors of government, combining their actions with those of civil society and the private sector and seeing that planned actions are implemented effectively through policies, programmes and projects, with their respective budgetary allocations.

It is important to stress that, even when the role of the State as the leader of this process is recognized and the efforts of different actors can be coordinated so that they work together towards the SDGs, the countries are constantly vulnerable to disasters. Any fortuitous event can become a national catastrophe (especially in small island States) with the potential to set back progress towards the SDGs despite a political commitment to attaining them.

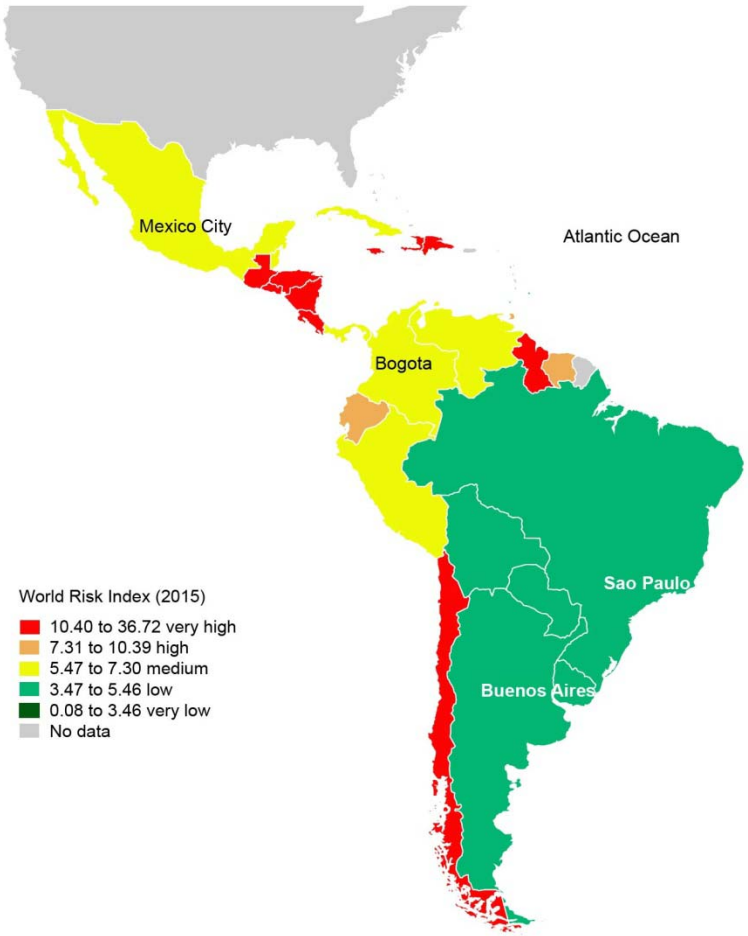
According to data from the World Risk Index, which evaluates countries' exposure and vulnerability to risks associated with natural phenomena, over 60% of the countries of Latin America and the Caribbean present medium to very high risk in the face of disasters (see map 1).[2] Of these, over half have high and very high risk levels. The effects of climate change in the region over recent years have led to natural phenomena becoming both more numerous and more intense. Everything seems to point to this situation being even more recurrent over the coming years.

The region thus faces the enormous challenge of achieving development at a time when great efforts will be required for it to adapt to the effects of climate change, mitigate disaster risks and reduce its vulnerability to these phenomena.

[1] Some countries have made use of existing institutions, i.e., have agreed on institutional mechanisms for renewing the designation of the body formerly responsible for the Millennium Development Goals (MDGs) so that it is now in charge of the SDGs. Other countries have set up a new coordination mechanism.

[2] The purpose of the World Risk Index is to allow risk arising from the threat of natural events to be understood. Disaster risk is defined as the product of the interaction between physical threats and the vulnerability of whatever is exposed to them.

Map 1
Latin America and the Caribbean: World Risk Index of natural disaster vulnerability



Source: Prepared by the authors on the basis of J. Birkmann and others, "World Risk Index: Concept and Results", *World Risk Report*, Bündnis Entwicklung Hilft, 2011 and T. Welle and J. Birkmann, "Der WeltRisikoIndex 2015", *WeltRisikoBericht 2015*, Bündnis Entwicklung Hilft/United Nations University Institute for Environment and Human Security.
Note: The boundaries and names shown on this map do not imply official endorsement or acceptance by the United Nations.

The 2030 Agenda for Sustainable Development lays great stress on disaster risk reduction as a key element in the attainment of the SDGs, and the following Goals and targets refer directly to this:

- SDG 1: End poverty (goal 1.5)
- SDG 2: Zero hunger (goal 2.4)
- SDG 3: Good health and well-being (goal 3.d)
- SDG 6: Clean water and sanitation (goal 6.6)
- SDG 9: Industry, innovation and infrastructure (goals 9.1 and 9.a)
- SDG 11: Sustainable cities and communities (goals 11.3, 11.5, 11.b and 11.c)
- SDG 13: Climate action (goals 13.1, 13.2, 13.3, 13.a and 13.b)
- SDG 14: Life below water (goal 14.2)
- SDG 15: Life on land (goal 15.3)

Disaster risk reduction affects different aspects of development, as an analysis of the 2030 Agenda makes clear. There are 17 goals relating directly to disaster risk management in 9 of the 17 SDGs of the 2030 Agenda and as many that relate indirectly to it, the clear conclusion being that this is a vital element in development strategies.

One area in which the 2030 Agenda for Sustainable Development recognizes and reaffirms the urgent need to reduce disaster risk is the economic sphere. A major disaster can obliterate several years' worth of economic and social gains in a country or region, making it harder for this society to attain the SDGs. Any sustainable development strategy needs to contain elements of disaster risk management.

The third United Nations World Conference on Disaster Risk Reduction and its main outcome, the Sendai Framework for Disaster Risk Reduction 2015-2030, call for a substantial reduction in disaster risk and the losses caused by disasters. These losses may be in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.[3]

The purpose of the Framework is to guide disaster risk management, and it establishes four priorities for this:

(i) understanding disaster risk;

(ii) strengthening disaster risk governance to manage disaster risk;

(iii) investing in disaster risk reduction for resilience;

(iv) enhancing disaster preparedness for effective response and to "build back better" in recovery, rehabilitation and reconstruction.

Disaster assessment as carried out by the Economic Commission for Latin America and the Caribbean (ECLAC) is consistent with these priorities. Specifically, estimating damage, losses and additional costs after a disaster allows risk to be quantified financially. Furthermore, priorities (ii), (iii) and (iv) are always reflected in the recommendations for resilient rebuilding in any ECLAC disaster assessment.

Since Principle 10[4] was adopted in 1992 as part of the Rio Declaration on Environment and Development, access rights have come to prominence in efforts to promote transparent, inclusive and responsible environmental governance. Principle 10 lays down three fundamental rights: access to information, access to public participation and access to justice. Here, systematic compilation of data on disasters can provide information of use to policymakers. Again, publicizing estimates of damage, losses and additional costs from disasters can raise awareness of the issue and empower citizens to engage in informed participation in decision-making processes.

Vulnerable populations and communities are disproportionately affected by climate disasters. For this reason, access rights, by highlighting vulnerabilities and providing information about them, also have an essential role to play in combating inequality and constructing inclusive climate

[3] The Sendai Framework was adopted by the United Nations General Assembly in 2015.

[4] "Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided" (United Nations, "Annex I: Rio Declaration on Environment and Development", *Report of the United Nations Conference on Environment and Development* (A/CONF.151/26), vol. I, New York, 1992).

resilience strategies. A recent achievement has been the adoption of the first binding regional agreement for protecting access rights: the Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean. The Agreement will be opened for signature by all countries of Latin America and the Caribbean at United Nations Headquarters in New York in September 2018. This is a great step towards sustainable development and international cooperation in the region.

Emphasis should also be laid on the importance given to planning in the Sendai Framework, which includes it among its priorities, goals, targets and guiding principles. First, the Framework is itself a planning instrument that provides countries with a guide to disaster risk management. Second, the exercise of planning for development, with the forecasting it entails, itself serves to coordinate actors and prepare strategies for reducing exposure and vulnerability to disasters of natural and human origin. Some of the aspects in which the importance of planning comes out are worth highlighting:

- **Leadership**: States have primary responsibility for preventing and reducing disaster risk, among other things, through cooperation.
- **Horizontal coordination**: responsibility is shared between central government and the authorities, sectors and parties concerned at national level, as the country's circumstances make advisable. Full participation by all State executive and legislative institutions at national and local level is also needed, as is consistency between different sectors' disaster risk reduction and sustainable development policies, plans, practices and mechanisms.
- **Vertical coordination**: local communities and authorities need to be empowered by means of resources, incentives and decision-making responsibilities, as appropriate.
- **Multi-actor collaboration**: disaster risk management requires the collaboration of all actors in society.
- **Public investment management**: public and private investment involving the application of structural and non-structural measures for disaster risk prevention and reduction is essential to increase the economic, social, health and cultural resilience of individuals, communities, countries and their assets, and of the environment. These factors can be drivers of innovation, growth and jobs.
- **Foresight**: decision-making needs to be inclusive and based on an understanding of risk, following a multi-hazard approach. In addition, the specific local characteristics of disaster risk need to be considered when risk reduction measures are decided on.

The ECLAC disaster assessment methodology also conforms to the priorities of the Sendai Framework, especially when it comes to enhancing preparedness for effective response to disasters by ensuring the capacities are in place to provide a basis for effective recovery. Planning also has a vital role to play here. Disasters have shown the need for advance preparation, not only for the immediate response, but also because the elements for a rapid assessment need to be in place. Some of these essential elements are sectoral data that serve to establish fundamental baselines for assessing damage and losses once a disaster has occurred. Sound intersectoral coordination mechanisms are required for this, and planning systems can help put them in place.

The 2030 Agenda for Sustainable Development and the Sendai Framework for Disaster Risk Reduction 2015-2030 offer guidance to countries looking to strengthen their planning processes with a view to achieving sustainable development by finding solutions to the threats posed by exposure and vulnerability to disasters. Attaining the SDGs will depend heavily on progress with disaster risk reduction. Consequently, there is a need to use planning to promote political engagement, investment in risk reduction and the adoption of measures to incorporate disaster resilience as key elements of sustainable development.

It is important to stress that disaster assessment is a crucial input in any reconstruction plan. In the case of the Caribbean islands, where disasters have nationwide implications, planning for reconstruction needs to take place within established national planning mechanisms.

ECLAC work on disaster assessment

ECLAC pioneered not only disaster assessment but also compilation of the necessary methodology and courses on this methodology for member countries and international institutions. Its first disaster assessment was in 1973, following the Managua earthquake of December 1972. Since then, ECLAC has led about 100 disaster assessments in 28 countries of the region.

The experience of ECLAC in this area has been presented in three editions of the *Handbook for Disaster Assessment*, in 1991, 2003 and 2014. The last of these was prepared in collaboration with the Pan American Health Organization (PAHO). The present publication contains exercises developed for the economic, social and environmental disaster assessment methodology courses and is a teaching supplement to the third edition of the *Handbook*. Since that came out, considerable efforts have been made to encourage wider use of it by means of national and regional courses.

The purpose of these exercises and the solutions to them is to reinforce the basic concepts used in estimating the effects of a disaster, namely damage, losses and additional costs, which are explained in the *Handbook for Disaster Assessment*.[5]

Damage means the impact on fixed assets that are wholly or partially destroyed and on stocks of final and semi-finished goods, raw material, materials and spare parts; in essence, harm caused to property by the disaster.

In addition, any disaster causes changes in flows that are classified into losses and additional costs. By losses are basically meant goods that go unproduced or services that go unprovided during a period of time following the occurrence of the disaster and, possibly, during the rehabilitation and reconstruction phase.

Additional costs are outlays required to produce goods and provide services as a result of the disaster. They reflect a response by both the public and the private sectors, which may take the form of additional spending or a recomposition of spending. A key issue for this concept is the question of what other sector benefits from the additional or reprogrammed spending.

It is necessary to distinguish between the two types of flows. Losses are obtained by comparing the outlook after the disaster with a baseline representing the evolution of each sector if it had never occurred. Both are hypothetical situations based on a variety of assumptions, and the same holds for whatever is estimated from them. Conversely, additional costs or recomposition of spending are outlays that are actually made in consequence of the event.

For this reason, national accounts treat these flows differently. Additional expenses represent a temporary increase in the intermediate consumption of the sector that is seeking to restore its output of goods or services, leading to a decline in its value added. The national component of additional expenses translates into an increase in production in another sector.

This publication presents 12 study exercises that serve to practise the methodology for estimating effects on the social, infrastructure and production sectors. They correspond to 10 chapters in the *Handbook*.

[5] Economic Commission for Latin America and the Caribbean (ECLAC), *Handbook for Disaster Assessment* (LC/L.3691), Santiago, 2014.

The early versions of the exercises in this publication were presented at disaster assessment methodology training sessions held after the third edition of the *Handbook* was published. Each exercise posits a hypothetical situation that is often based on the authors' experience in assessing disasters. The authors are grateful for the comments and questions of the participants in all these courses, which served to improve the exercises and develop them into the versions presented here. The courses are listed below in chronological order:

(a) 2014

- Economic and Social Commission for Western Asia (ESCWA). Beirut. The participants in this course were ESCWA staff.
- National Office for Emergencies of the Ministry of the Interior and Public Security (ONEMI). Santiago. This training was for ONEMI staff.

(b) 2015

- National Centre for Disaster Risk Assessment, Prevention and Reduction (CENEPRED) of Peru. Cusco, Lima, Moyobamba and Piura (Peru). The participants in these courses were staff of CENEPRED and other national and provincial organizations in Peru.
- Ministry of National Planning and Economic Policy (MIDEPLAN). San Jose. This course was held jointly with MIDEPLAN, and the participants were staff from MIDEPLAN and other public institutions in Costa Rica.
- Office of Disaster Preparedness and Management (ODPM). Port of Spain. This course was held jointly with ODPM and the participants were staff from ODPM and other public institutions in Trinidad and Tobago.

(c) 2016

- CENEPRED. Arequipa and Ica (Peru). These courses were taken by staff of CENEPRED and provincial governments in Peru.
- Panama City. This course was held jointly with the United Nations Office for Disaster Risk Reduction (UNISDR) and participated in by staff from that and other United Nations institutions with offices in Panama.
- Brazilian National Bank for Economic and Social Development (BNDES). Rio de Janeiro (Brazil). This course was for BNDES staff.
- National Emergency Secretariat (SEN). Asuncion. The course was held jointly with SEN and was for staff of SEN and other public agencies in Paraguay.

(d) 2017

- Association of Caribbean States (ACS). Port of Spain. This course was held jointly with ACS and participated in by staff from that institution and public officials from the following countries and territories: Aruba, Barbados, British Virgin Islands, Grenada, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.
- PAHO/WHO. Lima and Piura (Peru). These courses were held jointly with PAHO/WHO for health sector staff in Peru.
- Caribbean Disaster Emergency Management Agency (CDEMA). Bridgetown. Course held jointly with CDEMA and participated in by representatives of that institution and officials from Antigua and Barbuda, Barbados, Jamaica and Saint Kitts and Nevis.
- Ministry of the Interior, Public Works and Housing (MIOPV) of Argentina. Buenos Aires. Training for MIOPV staff and for national and provincial officials in which the 2016 floods were assessed.

(e) 2018

– Eastern Caribbean Central Bank (ECCB). Basseterre. The participants were staff from the institution. The ECCB joined with ECLAC in assessing hurricane Irma in Anguilla and Sint Maarten in 2017.

– Ministry of the Interior, Public Works and Housing (MIOPV) of Argentina. Rosario and San Salvador de Jujuy (Argentina). Course for officials of the provinces of Santa Fe and Jujuy.

– Tobago Emergency Management Agency (TEMA) of Trinidad and Tobago. This course was held jointly with TEMA and supported by the Inter-American Development Bank (IDB). The participants were staff from TEMA and different government institutions in Trinidad and Tobago.

Exercise 1: classification of effects

	Impact	Effects
1.	Farms in the area sustained impacts along 25 km of irrigation channels and the destruction of five tractors, while the roofs of eight material and food storage sheds collapsed	
2.	The two clinics in the area were destroyed, requiring the patients to be transferred to the general hospital and a nearby clinic, so that the number of emergencies dealt with increased and transfer costs were incurred	
3.	The heavy rainfall caused damage to 10,000 homes, leading the local government to prepare 15 shelters. The monthly cost of operating each shelter is estimated at 5 million monetary units (MUs) and will be met by the government	
4.	A collapse along 20 km of national highway has blocked access to the country's main port, suspending traffic. Some 200 t of agricultural export products are estimated to have been affected	
5.	The hurricane raised large waves that flooded and salinized 50 ha of agricultural land. It is estimated that land clean-up and recovery will cost about 100,000 MUs per hectare	
6.	The earthquake destroyed 37 schools and there have been long delays in setting up temporary schools, so that some 7,600 students have received no instruction for a month. The interruption is expected to last another two weeks	
7.	The local hoteliers' association has had reports of damage to 12 small hotels. The flooding affected furniture, equipment and electrical connections. The boats of two tour operators were also destroyed	
8.	In the telecommunications sector, two transmission towers and a control station are reported to have been brought down. In addition, the rain, landslides and wind have affected some 23 km of outdoor cables	
9.	The damage sustained by the telecommunications firm has resulted in the loss of mobile telephony service for some 85,000 users and of fixed Internet service for some 2,000 commercial users	
10.	Road closures have forced passenger transportation companies to use alternative routes, which has raised their operating costs by increasing fuel and oil consumption	
11.	The earthquake affected some 115,000 household water and sanitary connections, so that the water company's sales have dropped by some 12%. The interruption is expected to last for another two weeks	

(concluded)

	Impact	Effects
12.	The electricity company has set up five mobile generating plants to supply the worst-affected communities with electricity. The mobile plants will be in use for a month until service is restored	
13.	Strong winds affecting a tourist area have resulted in the cancellation of 90 international and 37 domestic flights and delayed the departure of a further 75 flights	

Answers

1. Damage; 2. Additional costs; 3. Additional costs; 4. Losses; 5. Damage; 6. Losses; 7. Damage; 8. Damage; 9. Losses; 10. Additional costs; 11. Losses; 12. Additional costs; 13. Losses.

I. The social sector

Exercise 2: education

The southern region of a small country was affected by a disaster on the first day of the school year. Education in the region is exclusively public. Some educational buildings were damaged as a result of the disaster. Education experts compiled the following information on the situation prior to the disaster (see tables 1 and 2).

Table 1
Education sector: population and students enrolled
(Numbers)

Population	90 000
Students enrolled (primary and secondary)	20 000

Table 2
Education sector: primary and secondary schools

Group	Average students per school	Number of schools	Total students	Teachers per group
1	2 500	1	2 500	75
2	1 000	15	15 000	350
3	500	5	2 500	50

An average monthly teacher's salary is 9,000 monetary units (MUs).

After analysing some reports and corroborating the information in a field visit, the group conducting the assessment produced the following information on the buildings affected and the recovery timetable (see table 3).

Table 3
Education sector: buildings affected, by type of damage

Group	100% damaged	50% damaged	25% damaged	Undamaged
1	0	0	0	1
2	4	1	5	5
3	3	1	1	0

Totally damaged buildings will be demolished. The cost of demolition and rubble removal is 1.5 million MUs for each building in group 2 and 1.2 million MUs for each building in group 3. The total costs of rubble removal for the other damaged buildings are 1.1 million MUs.

The Ministry of Education has provided the information that the cost of replacing furniture and equipment equates to 8% of that of the buildings (see table 4).

Table 4
Education sector: tentative timetable for restoring school buildings

Group	100% damaged	50% damaged	25% damaged
2	18 months	8 months	3 months
3	14 months	6 months	2 months

Before the disaster, it cost 50 million MUs to replace a typical group 1 school, 30 million for a group 2 school and 20 million for a group 3 school. The value of furniture and equipment is 8% of the total cost of replacing the infrastructure.

Using the information supplied:

(a) Estimate the baseline for the education sector.

(b) Estimate the damage in the education sector.

(c) Assuming that rebuilding costs are 30% greater than replacement costs for schools in group 2 and 25% greater for schools in group 3, estimate the financing required for rebuilding.

(d) Estimate the potential fall in classroom hours, assuming that the typical school day in the country is six hours and the school year lasts nine months.

(e) Following the methodology set out in the *Handbook for Disaster Assessment*, estimate the losses in the education sector deriving from the scenario described in letter (d).

(f) Estimate the additional costs.

(g) Estimate the additional costs again on the assumption that six temporary schools are brought into operation from the first day of the second month of classes in order to reduce the loss of teaching time. The cost of setting up each school is 1 million MUs. Monthly financing costs are 100,000 MUs.

Answers

(a) Table 5 presents the baseline as calculated from the information in table 2 and that gathered by the assessment group.

Table 5
Education sector: baseline
(Monetary units)

Group	Buildings	Valuation of buildings	Valuation of furnishings
1	1	50 000 000	4 000 000
2	15	450 000 000	36 000 000
3	5	100 000 000	8 000 000
Total	21	600 000 000	48 000 000

The damage baseline contains information on the value set on the different types of assets in this sector: (i) buildings: according to the information collected by the assessment team, each school consists of a single building (the value for each group is obtained by multiplying the replacement value by the number of buildings), and (ii) furniture and equipment (the valuation is carried out in this case by taking the value of the furniture and equipment to be 8% of the replacement cost).

(b) The damage in this sector is obtained from the information provided in table 3 on the replacement cost for typical schools in groups 2 and 3 (30 million and 20 million MUs, respectively), considering that the value of the furniture and equipment is 8% of the total infrastructure replacement cost (see table 6).

Table 6
Education sector: damage per building and type of impact
(Monetary units)

Infrastructure					
Group	100%	50%	25%	Undamaged	Total
1	0	0	0	0	0
2	120 000 000	15 000 000	37 500 000	0	172 500 000
3	60 000 000	10 000 000	5 000 000	0	75 000 000
Subtotal	180 000 000	25 000 000	42 500 000	0	247 500 000
Furniture and equipment					
Group	100%	50%	25%	Undamaged	Total
1	0	0	0	0	0
2	9 600 000	1 200 000	3 000 000	0	13 800 000
3	4 800 000	800 000	400 000	0	6 000 000
Subtotal	14 400 000	2 000 000	3 400 000	0	19 800 000
Total	194 400 000	27 000 000	45 900 000	0	267 300 000

In the case of infrastructure damage, the replacement cost was prorated by the percentage damage and by the number of units affected in each category. Infrastructure damage is 247.5 million MUs. To estimate furniture and equipment damage, the estimated infrastructure damage was multiplied by 0.08 for each group and degree of impact. The estimated damage totals 19.8 million MUs.

(c) The finance needed for rebuilding is estimated from the information supplied about extra costs over and above those of replacement. The estimate is made only for buildings that are going to be demolished, on the assumption that the same ratio is maintained between the infrastructure valuation and the machinery and equipment valuation (see table 7).

Table 7
Education sector: finance needed for rebuilding
(Monetary units)

Infrastructure					
Group	100%	50%	25%	Undamaged	Total
1	0	0	0	0	0
2	156 000 000	15 000 000	37 500 000	0	208 500 000
3	75 000 000	10 000 000	400 000		85 400 000
Total	231 000 000	25 000 000	37 900 000	0	293 900 000
Furniture and equipment					
Group	100%	50%	25%	Undamaged	Total
1	0	0	0	0	0
2	12 480 000	1 200 000	3 000 000	0	16 680 000
3	6 000 000	800 000	32 000	0	6 832 000
Subtotal	18 480 000	2 000 000	3 032 000	0	23 512 000
Total	249 480 000	27 000 000	40 932 000	0	317 412 000

(d) The estimated financing required for rebuilding is 317.4 million MUs (50.1 million MUs more than the replacement costs), with 92.6% of this being for infrastructure.

The following assumptions are applied to answer this question:

(i) the school year lasts nine months;

(ii) the school year begins on 1 March;

(iii) each month of activities has an average of 22 school days;

(iv) the school day is six hours.

The number of days that will elapse before schools restart the education cycle is estimated by taking assumptions (i) and (ii) along with the table 4 information. For example, we know that each school in group 2 will take 18 months to reopen. Since there are three months' vacations, 15 months of classes will be lost. Since every month has 22 days of classes, a total of 330 days will be lost. This procedure was applied to each school. The results can be seen in table 8.

Table 8
Education sector: classes potentially lost
(Days)

Group	100%	50%	25%
2	330	176	66
3	242	132	44

Using assumption (iii), days are converted into hours and multiplied by the number of students there were in the affected schools. This is how the total number of class hours lost by all students is obtained (see table 9).

Table 9
Education sector: potential class hours lost
(Total class hours)

Group	100%	50%	25%	Total
2	7 920 000	1 056 000	1 980 000	10 956 000
3	2 178 000	396 000	132 000	2 706 000
Total	10 098 000	1 452 000	2 112 000	13 662 000

The estimate for the number of class hours lost by all students is 13.7 million. Note that this is the number of class hours lost by students in the event that the public sector does not react to the disaster.

(e) Because all education is public, losses are estimated by multiplying the monthly wage of teachers by the number of teachers in the schools affected and the number of months it will take to bring them back into operation (see table 10). The information for this recovery time was presented in table 4.

Table 10
Education sector: losses
(Monetary units)

Group	100%	50%	25%	Total
1	0	0	0	0
2	12 600 000	1 680 000	3 150 000	17 430 000
3	2 970 000	540 000	180 000	3 690 000
Total	15 570 000	2 220 000	3 330 000	21 120 000

Losses are estimated at 21.1 million MUs. Note that they are not incurred in a single school year or indeed in a single calendar year, as restoration or rebuilding of the destroyed schools takes more than a year.

(f) With the information provided, the additional costs are for demolition and rubble removal. Demolition costs are shown in table 11.

Table 11
Education sector: additional costs
(Monetary units)

Group	100% damaged
2	6 000 000
3	3 600 000
Total	9 600 000

Additional costs total 10.7 million MUs, consisting of demolition costs of 9.6 million MUs plus 1.1 million MUs for the removal of rubble from buildings with 50% and 25% damage.

(g) The additional costs incurred in establishing temporary schools are shown in table 12.

Table 12
Education sector: additional costs
(Monetary units)

	Installation costs	Running costs	Total
Temporary school 1	1 000 000	900 000	1 900 000
Temporary school 2	1 000 000	900 000	1 900 000
Temporary school 3	1 000 000	900 000	1 900 000
Temporary school 4	1 000 000	900 000	1 900 000
Temporary school 5	1 000 000	900 000	1 900 000
Temporary school 6	1 000 000	900 000	1 900 000
Total	6 000 000	5 400 000	11 400 000

The estimated operating cost per school is 900,000 MUs, since the school year lasts nine months. The estimated total additional cost associated with the temporary schools is 11.4 million MUs.

Exercise 3: health

A disaster severely affected the health-care sector in region 4 of a country. The group of specialists carrying out the assessment has gathered the following information on the impact sustained by health-care buildings for which the government is responsible:

(i) A hospital whose infrastructure was valued at 300 million MUs was destroyed. It is calculated that replacing or rebuilding it will take three years. Another hospital with the same characteristics was unaffected.

(ii) The cost of removing rubble is 15 million MUs.

(iii) The hospital's equipment was valued at 60 million MUs. All this equipment is made abroad.

(iv) In the hospital there were also inventories of medical supplies valued at 6 million MUs. It is estimated that 75% was imported (the exchange rate is 6 MUs per dollar).

(v) The hospital carried out an average of 600 consultations (including emergency consultations) and 40 operations each day. It had 100 beds for hospitalization.

(vi) Two public health establishments with a replacement cost of 20 million MUs apiece sustained minor damage, amounting to a combined total of 6.2 million MUs, which has to be repaired in a month. No damage to medical supplies or equipment was reported.

(vii) Each establishment carried out 60 consultations a day, with no operations. Another three similar public establishments sustained no damage.

From the information provided:

(a) Estimate the baseline for the damage.

(b) Estimate the total damage. What percentage of this damage affects imported components? Estimate the impact on imports.

(c) It is calculated that the incorporation of disaster risk reduction features entails an increase of 40% in the cost of building the hospital. There is also the intention of adding latest-technology equipment, which involves a 20% increase in costs. Lastly, the plan provides for the possibility of adding an auxiliary power plant with a cost of 6 million MUs. Estimate the rebuilding cost and compare it with your answer (b).

(d) Estimate the baseline for the losses in terms of consultations, surgical operations and hospitalizations.

(e) Estimate the annual losses in terms of consultations, surgical operations and hospitalizations foregone. Bear in mind that the public sector is assumed not to react after the disaster.

(f) Given that all the institutions affected are public, calculate the losses if the total wages paid monthly to hospital staff are 3 million MUs. In the case of health centres, the figure is 0.5 million MUs a month.

The public sector response is to bring three temporary hospitals into operation. The plan is to keep them operating until the destroyed hospital has been restored or rebuilt. The hospitals will be up and running one month after the disaster. The costs of each hospital are as follows:

- 15 million MUs for the structure, equipment and furniture.
- Monthly spending on inputs of 0.2 million MUs.
- Monthly spending on wages of 0.5 million MUs.

The government receives the following donations: money from country A to defray the costs of setting up one of the hospitals and a donation in kind from country B for one of the temporary hospitals.

(g) Estimate the additional costs for each year. Estimate what percentage of these costs is financed by the government.

Answers

(a) The baseline for the health sector's assets is presented in table 13. In the case of health-care establishments, there is no information on medical supplies and equipment.

Table 13
Health sector: baseline for assets
(Monetary units)

Establishment	Infrastructure	Equipment	Inputs
Hospital 1	300 000 000	60 000 000	6 000 000
Hospital 2	300 000 000	60 000 000	6 000 000
Health establishment 1	20 000 000		
Health establishment 2	20 000 000		
Health establishment 3	20 000 000		
Health establishment 4	20 000 000		
Health establishment 5	20 000 000		
Total	700 000 000	120 000 000	12 000 000

(b) Tables 14, 15 and 16 present damage valuations for the different types of health sector assets (infrastructure, medical equipment and medical inputs). The source of these estimates is the information gathered by the assessment group, as listed in points (i) to (iii) of the exercise. It is good practice to have a breakdown of these estimates by asset type (see table 17).

Table 14
Health sector: infrastructure damage
(Monetary units)

Type of establishment	Damaged units	Infrastructure valuation	Value of damage to health units
Hospitals	1	300 000 000	300 000 000
Health establishments	2	20 000 000	6 200 000
Total			306 200 000

Table 15
Health sector: equipment damage
(Monetary units)

Type of establishment	Damaged units	Equipment valuation	Value of damage to equipment
Hospitals	1	60 000 000	60 000 000
Health establishments	2	0	0
Total			60 000 000

Table 16
Health sector: damage to medical inputs
(Monetary units)

Type of establishment	Damaged units	Medical inputs valuation	Value of damage to medical inputs
Hospitals	1	6 000 000	6 000 000
Health establishments	2	0	0
Total			6 000 000

Table 17
Health sector: total damage
(Monetary units)

Health units damaged	Value of infrastructure damage	Value of equipment damage	Value of medical inputs damage	Total damage
Hospitals	300 000 000	60 000 000	6 000 000	366 000 000
Health establishments	6 200 000	0	0	6 200 000
Total	306 200 000	60 000 000	6 000 000	372 200 000

Table 18 gives estimates for the value of the imported component of the damage.

Table 18
Health sector: imported component of total damage
(Monetary units and dollars)

Description	Damage valuation *(MUs)*	Percentage	Imported component of damage *(MUs)*	Exchange rate *(MUs per dollar)*	Total *(dollars)*
Imported equipment	60 000 000	100	60 000 000	6	10 000 000
Medical inputs	6 000 000	75	4 500 000	6	750 000
Total			64 500 000	6	10 750 000

Restoring damaged assets in this sector requires an increase of about US$ 10.8 million in imports.

(c) Estimated cost of rebuilding (see table 19).

Table 19
Health sector: cost of rebuilding
(Monetary units)

Health units damaged	Cost of new infrastructure	Cost of new equipment	Cost of power plant	Total rebuilding cost
Hospitals	420 000 000	72 000 000	6 000 000	498 000 000
Health establishments	6 200 000	0	0	6 200 000
Total	426 200 000	72 000 000	6 000 000	504 200 000

Note that the estimated rebuilding cost exceeds the damage estimate by 132 million MUs because this process is intended to incorporate a number of improvements into the assets, including a reduction in disaster risk.

(d) Table 20 presents the baseline for losses in terms of consultations, surgical operations and hospitalizations.

Table 20
Health sector: baseline for flows
(Monthly figures)

Establishment	Consultations	Surgical operations	Bed days
Hospital 1	15 000	1 000	3 000
Hospital 2	15 000	1 000	3 000
Health establishment 1	1 800		
Health establishment 2	1 800		
Health establishment 3	1 800		
Health establishment 4	1 800		
Health establishment 5	1 800		
Total	39 000	2 000	6 000

The health sector in region 4 was able to carry out 39,000 consultations and 2,000 surgical operations a month, and had a capacity of 6,000 bed days. These estimates were arrived at on the assumption that consultations and operations were carried out in the hospital on 25 days a month.

(e) On the assumption that there is no reaction from the public sector after the disaster, tables 21, 22 and 23 present losses in terms of consultations, surgical operations and hospitalizations foregone in the different years.

Table 21
Health sector: flows foregone
(Year 1)

Health units damaged	Months	Total consultations foregone	Surgical operations per hospital annually	Number of bed days for hospitalization
Hospital 1	12	180 000	12 000	36 000
Health establishment 1	1	1 800	0	0
Health establishment 2	1	1 800	0	0
Total		183 600	12 000	36 000

Table 22
Health sector: flows foregone
(Year 2)

Health units damaged	Months	Total consultations foregone	Surgical operations per hospital annually	Number of bed days for hospitalization
Hospital 1	12	180 000	12 000	36 000
Total		180 000	12 000	36 000

Table 23
Health sector: flows foregone
(Year 3)

Health units damaged	Months	Total consultations foregone	Surgical operations per hospital annually	Number of bed days for hospitalization
Hospital 1	12	180 000	12 000	36 000
Total		180 000	12 000	36 000

These estimates were based on the information gathered by the assessment team to the effect that the damaged health establishments would be repaired in a month and the hospital would be rebuilt in three years. The information from the answer to the previous question was also used.

(f) Estimated losses in terms of monetary units are set out in table 24 below. As explained in the *Handbook for Disaster Assessment* (2014), the estimates are based on wages paid.

Table 24
Health sector: losses
(Monetary units)

Health units damaged	Months units will be closed for	Total monthly wages	Losses
		Year 1	
Hospitals	12	3 000 000	36 000 000
Health establishment 1	1	500 000	500 000
Health establishment 2	1	500 000	500 000
Total		4 000 000	37 000 000
		Year 2	
Hospitals	12	3 000 000	36 000 000
Total		3 000 000	36 000 000
		Year 3	
Hospitals	12	3 000 000	36 000 000
Total		3 000 000	36 000 000

(g) The additional costs estimated are presented in tables 25, 26 and 27 below.

Table 25
Health sector: additional costs[a]
(Year 1)

	Installation costs	Spending on inputs	Spending on wages	Total
Temporary hospital 1	15 000 000	2 200 000	5 500 000	22 700 000
Temporary hospital 2	15 000 000	2 200 000	5 500 000	22 700 000
Temporary hospital 3	15 000 000	2 200 000	5 500 000	22 700 000
Total	45 000 000	6 600 000	16 500 000	68 100 000

[a] Government spending to finance the additional costs is 38.1 million MUs in year 1, as the cost of setting up two hospitals is financed out of international assistance. A period of 11 months was taken to estimate spending on inputs and wages, as the hospitals are set up a month after the disaster. Government spending finances 56% of total costs in year 1.

Table 26
Health sector: additional costs
(Year 2)

	Installation costs	Spending on inputs	Spending on wages	Total
Temporary hospital 1	0	2 400 000	6 000 000	8 400 000
Temporary hospital 2	0	2 400 000	6 000 000	8 400 000
Temporary hospital 3	0	2 400 000	6 000 000	8 400 000
Total	0	7 200 000	18 000 000	25 200 000

Table 27
Health sector: additional costs
(Year 3)

	Installation costs	Spending on inputs	Spending on wages	Total
Temporary hospital 1	0	2 400 000	6 000 000	8 400 000
Temporary hospital 2	0	2 400 000	6 000 000	8 400 000
Temporary hospital 3	0	2 400 000	6 000 000	8 400 000
Total	0	7 200 000	18 000 000	25 200 000

Government spending finances 100% of the additional costs in the health sector in years 2 and 3. The installation costs were fully disbursed in year 1.

Exercise 4: housing

The team assessing an earthquake in the central region of a country ascertains that 45,000 homes have been damaged as a result of the event. The impact on dwellings has been divided into three categories:

- Type I: destroyed or with irreparable structural damage (100%).
- Type II: considerable damage to 50% of the structure, recoverable.
- Type III: minimal damage to 20% of the structure, quickly repairable.

It is estimated that 58% of the damaged homes were in urban areas and 42% in rural areas. In urban areas, 7,830 dwellings were classified as type I, 11,745 as type II and 6,525 as type III. In rural areas, 8,505 dwellings presented type I damage, 7,560 type II damage and 2,835 type III damage.

According to the Ministry of Housing, the country's buildings are divided into three types: single family dwellings, apartments and makeshift houses. The assessment team found the following impacts by type of dwelling:

(i) Urban areas

- Of dwellings suffering a type I impact, 30% are single-family, 20% apartments and 50% makeshift dwellings.
- Of dwellings suffering a type II impact, 40% are single-family, 20% apartments and 40% makeshift dwellings.
- Of dwellings suffering a type III impact, 24% are single-family, 16% apartments and 60% makeshift dwellings.

(ii) Rural areas

- Of dwellings suffering a type I impact, 40% are single-family, 20% apartments and 40% makeshift dwellings.
- Of dwellings suffering a type II impact, 40% are single-family, 10% apartments and 50% makeshift dwellings.
- Of dwellings suffering a type III impact, 20% are single-family, 40% apartments and 40% makeshift dwellings.

The destruction of dwellings left 90,000 m^3 of rubble, and the demolition of structurally damaged dwellings is expected to leave another 30,000 m^3 of rubble.

The local construction association and the Ministry of Housing provided the assessment team with information on replacement prices for the different types of urban dwelling (see table 28). Because of the lack of information on rural areas, the assessment team, in coordination with the government, has decided to use the same replacement costs for these areas.

Table 28
Housing sector: cost of replacing affected dwellings, furniture and equipment
(Monetary units)

Type of damage	Single-family dwelling		Apartment		Makeshift dwelling	
	Building	Furniture and equipment	Building	Furniture and equipment	Building	Furniture and equipment
I	22 000 000	3 300 000	16 000 000	2 400 000	7 000 000	1 050 000
II	9 000 000	1 350 000	5 000 000	750 000	1 000 000	150 000
III	2 000 000	300 000	1 000 000	150 000	400 000	60 000

According to information from the latest population census, the average household size is five people. Consequently, 225,000 people are estimated to be affected. The whole of the affected population will be lodged in shelters until the dwellings are repaired or rebuilt. The shelters will provide each affected household with a tent.

It is estimated that the families occupying dwellings that suffered a type I impact will remain in the shelters for 22 months, while those suffering a type II impact will be in the shelters for 12 months and those suffering a type III impact for just 2 months.

The assessment team obtained the following cost information:

(i) Tents: 300,000 MUs apiece.

(ii) The cost of operating the shelter is 20 MUs per person per day.

(iii) The monthly cost of labour at the shelter is estimated at 7 million MUs.

(iv) The cost of removing rubble is 15 MUs per cubic metre.

(v) The average monthly rent in urban areas is 2,000 MUs for a single-family dwelling and 1,500 MUs for an apartment. In addition, the assessment team obtained information on the rental cost for makeshift dwellings. This is estimated at 800 MUs a month.

(vi) The average monthly rent in rural areas is 1,500 MUs for single-family dwellings and 1,000 MUs for apartments. According to interviews, the average monthly rent for makeshift rural dwellings is 500 MUs.

Using the information provided:

(a) Identify the buildings affected by location and type of damage.

(b) Estimate the cost of the damage in the sector.

(c) Estimate the losses.

(d) Estimate the additional costs resulting from the impact in this sector.

(e) In the process of rebuilding the dwellings, improvements will be made to increase their resilience to future events. Consequently, it is estimated that the cost of rebuilding a single-family dwelling is 20% greater than the cost of replacing the building as such. The cost increase will be 13% for apartments and 37% for makeshift dwellings.

Answers

(a) According to the information gathered by the assessment team and the Ministry of Housing, 58% of the damaged dwellings were in urban areas and 42% in rural areas. The disaggregation by dwelling type, level of damage and location was supplied by the Ministry of Housing and is presented in table 29.

Table 29
Housing sector: dwellings affected
(Numbers)

Impact type	Urban areas			Rural areas		
	Single-family dwelling	Apartment	Makeshift dwelling	Single-family dwelling	Apartment	Makeshift dwelling
Type I	2 349	1 566	3 915	3 402	1 701	3 402
Type II	4 698	2 349	4 698	3 024	756	3 780
Type III	1 566	1 044	3 915	567	1 134	1 134
Total	8 613	4 959	12 528	6 993	3 591	8 316

(b) Tables 28 and 29 contain the information required to estimate damage in the housing sector, which is given below. Damage to housing infrastructure and furniture and equipment is estimated at 193,897 million MUs in urban areas and 187,887 million MUs in rural areas (see tables 30 and 31).

Table 30
Housing sector: damage in urban areas
(Monetary units)

Impact type	Dwelling type			
	Single-family dwelling			
	Number of buildings	Value of building	Value of equipment and furniture	Subtotal
Type I	2 349	22 000 000	3 300 000	59 429 700 000
Type II	4 698	9 000 000	1 350 000	48 624 300 000
Type III	1 566	2 000 000	300 000	3 601 800 000
Subtotal	8 613			111 655 800 000
		Apartment		
Type I	1 566	16 000 000	2 400 000	28 814 400 000
Type II	2 349	5 000 000	750 000	13 506 750 000
Type III	1 044	1 000 000	150 000	1 200 600 000
Subtotal	4 959			43 521 750 000
		Makeshift dwelling		
Type I	1 566	7 000 000	1 050 000	31 515 750 000
Type II	2 349	1 000 000	150 000	5 402 700 000
Type III	1 044	400 000	60 000	1 800 900 000
Subtotal	4 959			38 719 350 000
Total	26 100			193 896 900 000

Table 31
Housing sector: damage in rural areas
(Monetary units)

Impact type	Dwelling type			
	Single-family dwelling			
	Number of buildings	Value of building	Value of equipment and furniture	Subtotal
Type I	3 402	22 000 000	3 300 000	86 070 600 000
Type II	3 024	9 000 000	1 350 000	31 298 400 000
Type III	567	2 000 000	300 000	1 304 100 000
Subtotal	6 993			118 673 100 000
		Apartment		
Type I	1 701	16 000 000	2 400 000	31 298 400 000
Type II	756	5 000 000	750 000	4 347 000 000
Type III	1 134	1 000 000	150 000	1 304 100 000
Subtotal	3 591			36 949 500 000
		Makeshift dwelling		
Type I	3 402	7 000 000	1 050 000	27 386 100 000
Type II	3 780	1 000 000	150 000	4 347 000 000
Type III	1 134	400 000	60 000	521 640 000
Subtotal	8 316			32 254 740 000
Total	18 900			187 877 340 000

Information on replacement costs was only available for urban areas because of deficiencies in the collection of data on rural areas. Consequently, in coordination with the Ministry of Housing, the assessment team assigned the same replacement costs to rural areas.

(c) Tables 32 and 33 present estimates for urban and rural losses. Estimating losses requires information on the number and type of dwellings affected (see table 29), rental costs (points (v) and (vi) of the exercise) and the length of the interruption to the accommodation service.

Table 32
Housing sector: losses in urban areas
(Monetary units)

Impact type	Dwelling type			
	Single-family dwelling			
	Number of buildings	Monthly rent	Length of interruption *(months)*	Subtotal
Type I	2 349	2 000	22	103 356 000
Type II	4 698	2 000	12	112 752 000
Type III	1 566	2 000	2	6 264 000
Subtotal	8 613			222 372 000
		Apartment		
Type I	1 566	1 500	22	51 678 000
Type II	2 349	1 500	12	42 282 000
Type III	1 044	1 500	2	3 132 000
Subtotal	4 959			97 092 000
		Makeshift dwelling		
Type I	3 915	800	22	68 904 000
Type II	4 698	800	12	45 100 800
Type III	3 915	800	2	6 264 000
Subtotal	12 528			120 268 800
Total	26 100			439 732 800

Table 33
Housing sector: losses in rural areas
(Monetary units)

Impact type	Dwelling type			
	Single-family dwelling			
	Number of buildings	Monthly rent	Length of interruption *(months)*	Subtotal
Type I	3 402	1 500	22	112 266 000
Type II	3 024	1 500	12	54 432 000
Type III	567	1 500	2	1 701 000
Subtotal	6 993			168 399 000
		Apartment		
Type I	1 701	1 000	22	37 422 000
Type II	756	1 000	12	9 072 000
Type III	1 134	1 000	2	2 268 000
Subtotal	3 591			48 762 000

Table 33 (concluded)

Impact type	Dwelling type			
	Single-family dwelling			
	Number of buildings	Monthly rent	Length of interruption *(months)*	Subtotal
	Makeshift dwelling			
Type I	3 402	500	22	37 422 000
Type II	3 780	500	12	22 680 000
Type III	1 134	500	2	1 134 000
Subtotal	8 316			61 236 000
Total	18 900			278 397 000

(d) The additional costs are presented in tables 34 and 35 and include costs associated with the provision of shelter and housing, plus rubble removal. The estimation was carried out using the information presented in points (i) to (iv) of the exercise.

Table 34
Housing sector: general additional costs
(Monetary units)

Description	Number	Cost	Total
Rubble removal	120 000	15	1 800 000
Tents	45 000	300 000	13 500 000 000
Labour cost for the shelter	22	7 000 000	154 000 000
Subtotal			13 665 800 000

Table 35
Housing sector: additional costs per shelter
(Monetary units)

Description	Number of dwellings affected	Number of people	Daily operating cost per person	Duration of stay (days)	Total
Type I	16 335	81 675	20	660	1 078 110 000
Type II	19 305	96 525	20	360	694 980 000
Type III	20 844	104 220	20	60	125 064 000
Subtotal	45 000	225 000			1 898 154 000

Adding together tables 34 and 35 yields an additional costs total of 15,563,954,000 MUs.

(e) Estimation of rebuilding costs. According to the information supplied, the cost of rebuilding a single-family dwelling is 20% more than the cost of the building. Apartments will cost 13% more and makeshift dwellings 37% more (see tables 36 and 37). This increase applies only to totally destroyed dwellings, which are the only ones that will be rebuilt. In the case of type II and type III impacts, infrastructure damage will be taken.

The cost of rebuilding exceeds the damage by 52,617 million MUs, as the intention is to incorporate disaster risk reduction measures. Furthermore, consideration is being given to a major effort to improve the quality and safety of dwellings that were already classified as makeshift before the event.

Table 36
Housing sector: rebuilding costs in urban areas
(Monetary units)

Impact type	Dwelling type				
	Single-family dwelling				
	Number of buildings	Building value	Increase when rebuilding	Rebuilding value	Subtotal
Type I	2 349	22 000 000	20%	26 400 000	62 013 600 000
Type II	4 698	9 000 000			42 282 000 000
Type III	1 566	2 000 000			3 132 000 000
Subtotal	8 613				107 427 600 000
			Apartment		
Type I	1 566	16 000 000	13%	18 080 000	28 313 280 000
Type II	2 349	5 000 000			11 745 000 000
Type III	1 044	1 000 000			1 044 000 000
Subtotal	4 959				41 102 280 000
			Makeshift dwelling		
Type I	2 133	7 000 000	37%	9 590 000	37 544 850 000
Type II	2 178	1 000 000			4 698 000 000
Type III	5 049	400 000			1 566 000 000
Subtotal	9 360				43 808 850 000
Total	26 100				192 338 730 000

Table 37
Housing sector: rebuilding costs in rural areas
(Monetary units)

Impact type	Dwelling type				
	Single-family dwelling				
	Number of buildings	Building value	Increase when rebuilding	Rebuilding value	Subtotal
Type I	3 402	22 000 000	20%	26 400 000	89 812 800 000
Type II	3 024	9 000 000			27 216 000 000
Type III	567	2 000 000			1 134 000 000
Subtotal	6 993				118 162 800 000
			Apartment		
Type I	1 701	16 000 000	13%	18 080 000	30 754 080 000
Type II	756	5 000 000			3 780 000 000
Type III	1 134	1 000 000			1 134 000 000
Subtotal	3 591				35 668 080 000
			Makeshift dwelling		
Type I	3 402	7 000 000	37%	9 590 000	32 625 180 000
Type II	3 780	1 000 000			3 780 000 000
Type III	1 134	400 000			2 019 600 000
Subtotal	8 316				38 424 780 000
Total	18 900				192 255 660 000

II. The infrastructure sector

Exercise 5: transport

A region of a small country has been affected by heavy rainfall. One consequence was a landslide that blocked and damaged highway I-5, requiring repair works to restore service.

The National Highways Institute provides the team of experts with information. The landslide has affected 10.6 km of road and the clean-up is expected to take 15 days. The highway was built by the public sector, so the Ministry of Infrastructure is responsible for maintaining it. It is a toll road, but the Ministry has decided to waive charges for the next two months to contribute to the area's recovery. The assessment team has obtained information on the volume of vehicles and the cost of the tolls (see table 38).

Table 38
Transport sector: daily traffic volume

Vehicle type	Daily traffic volume	Cost of toll *(monetary units)*
Motorcycles	2 374	230
Light automobiles	6 812	350
Buses	492	690
Trucks (two axles)	315	870
Trucks (four axles)	402	1 530

The landslide left some 120,000 m^3 of rubble. Rubble removal costs 90 MUs per cubic metre. In addition, the affected section needs repairing. The cost per kilometre is 7.4 million MUs.

The area is served by eight public transport bus operators and two taxi companies. The Association of Transport Operators reports to the assessment team that 15 buses have had their electrical systems severely damaged and the cost of repairing each bus is estimated at 800,000 MUs. One taxi firm reported no damage to its units, but its car park and administrative offices sustained major damage to roofs, windows and electrical systems. Repair is expected to take two months, during which time the firm will have to rent a car park and office to continue its business. The monthly cost is 1 million MUs. Repair costs are estimated at 8.5 million MUs.

Using the information above:

(a) Estimate the damage.

(b) Estimate the profit foregone from the tolls that go uncollected.

(c) Estimate the additional costs.

There will be a diversion of 30 km while highway I-5 is being repaired, resulting in an increase of 40% in the rate per ton-kilometre and of 25% per passenger-kilometre. Before the event, the rate per ton-kilometre was 10 MUs and the volume transported was 100,000 t per day. After the disaster this volume fell by 20%. Before the event, the rate per passenger-kilometre was 0.1 MUs and volume was 50,000 passengers a day, a figure that fell by 30% after the event.

(d) Calculate the change in gross production value (GPV) expected before and after the disaster.

Answers

(a) There are reports of damage to the highway and the assets of the firms providing transport services (see table 39).

Table 39
Transport sector: damage
(Monetary units)

Description	Quantity	Unit cost	Total
Highway impact	15	7 400 000	111 000 000
Buses	15	800 000	12 000 000
Office and car park	1	8 500 000	8 500 000
Total			131 500 000

(b) The profit foregone from tolls left uncollected is estimated from information on the type of vehicles using the highway, the daily volume of each vehicle type, the cost of the toll and the duration of the closure. The losses are estimated from the information presented in table 38 and the decision by the Ministry of Transport not to charge tolls for two months (see table 40).

Table 40
Transport sector: profit foregone by waiving tolls
(Monetary units)

Vehicle type	Daily traffic volume	Cost of toll *(monetary units)*	Duration of closure	Total
Motorcycles	2 374	230	60	32 761 200
Light automobiles	6 812	350	60	143 052 000
Buses	492	690	60	20 368 800
Trucks (two axles)	315	870	60	16 443 000
Trucks (four axles)	402	1 530	60	36 903 600
Total				249 528 600

(c) Estimation of additional costs. According to the information compiled by the assessment team, the additional costs for the public sector are an estimated 10.8 million MUs, while the private sector reports 2 million MUs (see table 41).

Table 41
Transport sector: additional costs
(Monetary units)

Description	Quantity	Cost	Total
Rubble removal	120 000	90	10 800 000
Rental of office and car park	2	1 000 000	2 000 000
Total			12 800 000

(d) Estimating the change in GPV requires calculation of a baseline, namely the level of sales expected before the disaster. The result is then compared with actual sales by the firms after the disaster (see tables 42 and 43).

Table 42
Transport sector: gross production value baseline
(Monetary units)

Description	Daily volume	Cost per kilometre	Distance *(kilometres)*	Daily total
Cargo	100 000	10	10.6	10 600 000
Passengers	50 000	0.1	10.6	53 000

Table 43
Transport sector: change in gross production value
(Monetary units)

Description	Daily volume	Cost per kilometre	New distance *(kilometres)*	Daily total
Cargo	80 000	14	30	33 600 000
Passengers	35 000	0.125	30	131 250

The estimate has been carried out for the 30 km diversion. In the case of cargo transportation, the firm's GPV rises from 10.6 million MUs before the event to 33.6 million afterwards. Passenger transportation GPV rises from 53,000 MUs before the event to 131,250 MUs after it.

Exercise 6: water and sanitation

A region of a small country was affected by severe flooding. There are 48,000 homes in the area. The region is served by Agua y Alcantarillado (AyA), which provides water and sewage services to 80% of households, and by Residuos y Limpieza (RyL), which provides the same households with waste collection services.

AyA has four water purification plants. The information obtained in the population census indicates that the average household size is four people. It is estimated that one four-member household consumes 155 m^3 of water a year. The selling price is 100 MUs per cubic metre of water (see table 44).

Table 44
Water and sanitation sector: sales of water per plant

Plant	Water sold *(cubic metres per year)*	Impact	Coverage *(number of households)*
1	1 937 500	Completely destroyed	12 500
2	1 937 500	Partially damaged	12 500
3	1 038 500	Partially damaged	6 700
4	1 038 500	Unaffected	6 700

Plant 1 will be closed for six months and will not provide its customers with services, while plants 2 and 3 will remain shut for four weeks. The local government will use tanker trucks to supply water during that time. The cost per household is estimated at 50 MUs a week, and the service will cover households normally supplied by plants 1, 2 and 3.

Because of deficiencies in the sector's infrastructure and the distance from other plants, plant 1 cannot be supplied during the shutdown. Plant 1 provides services to marginal communities in the area. Accordingly, the local government has decided to set up a small mobile plant and not charge for the service during the six months' interruption (the cost per cubic metre of water is estimated at 160 MUs). The plant's monthly operating cost is 450,000 MUs and will be met by the supplier firm. However, an international cooperation agency has decided to meet the costs of providing water for six months.

Plant 1 is estimated to have had equipment and supplies worth 90 million MUs, while the cost of repairing the building is 800 million MUs. Plant 2 sustained 70% damage to its structure and inventory; the total inventory is estimated at 75 million MUs. Plant 3 has 75% damage to its building and inventory; the inventory is estimated at 40 million MUs. It is known that fully repairing plants 2 and 3 will cost 680 and 550 million MUs, respectively.

The heavy rain affected a water purification plant with a storage capacity of 100,000 m^3. The cost of repairing the plant is estimated at 300 million MUs. The cost of the chemicals needed to purify the water is 500 MUs per 1,000 m^3. In addition, 15 km of sewers were damaged and the flooding left 50,000 m^3 of mud. The cost of repairing the sewers is estimated at 200,000 MUs per kilometre. A firm has been engaged for rubble removal at a rate of 90 MUs per cubic metre.

RyL sustained substantial damage to its waste treatment plant, so that it will not be able to service any of its customers for a month. The monthly price of the service is 100 MUs. The cost of repairing the plant is estimated at 150 million MUs. In addition, five waste disposal trucks were damaged by the heavy rains. Each truck has a replacement cost of 20 million MUs.

Using the information provided:

(a) Estimate the damage in the sector.

(b) Establish the baseline for gross revenues from selling water and collecting waste for the first year.

(c) Estimate the reduction in revenues from selling water and collecting waste after the event.

(d) Estimate the additional costs and identify the organization liable for each.

(e) Assume that rebuilding costs are 30% greater in the case of plants 1 and 2 and 25% in the case of plants 3 and 4. In addition, plant 1 lost all its inventory and equipment, plant 2 lost 70% and plant 3 lost 75%. All supplies and equipment have to be imported, and it is estimated that the cost of replacement will be 15% greater. Estimate the financing required for rebuilding.

Answers

(a) The damage was estimated by prorating the replacement cost by the percentage damage sustained by each type of asset. Plant 1 suffered a 100% impact to its building and inventories, plant 2 a 70% impact and plant 3 a 75% impact (see table 45).

Table 45
Water and sanitation sector: damage
(Monetary units)

Description	Building cost	Inventory cost
Plant 1	800 000 000	90 000 000
Plant 2	476 000 000	52 500 000
Plant 3	412 500 000	30 000 000
Purification plant	300 000 000	-
Waste treatment plant	150 000 000	-
Sewers	30 000 000	-
Trucks	100 000 000	-
Subtotal	2 268 500 000	172 500 000
Total	2 441 000 000	

(b) The baseline for gross revenues are the sales that the two firms AyA and RyL expected to make during the year before the disaster. Table 44 presents data on the amount of water sold per year and on the number of customers supplied by each of the plants. The information compiled indicates that the cost per cubic metre of water is 100 MUs (see table 46).

Table 46
Water and sanitation sector: gross revenues baseline, AyA
(Monetary units)

Plant	Water sold *(cubic metres per year)*	Selling price per cubic metre of water *(monetary units)*	Total expected sales
Plant 1	1 937 500	100	193 750 000
Plant 2	1 937 500	100	193 750 000
Plant 3	1 038 500	100	103 850 000
Plant 4	1 038 500	100	103 850 000
Total			595 200 000

According to the information obtained, RyL serves the same customers as AyA. The firm has informed the assessment team of the cost of the service for the purpose of estimating the sales expected in the year before the disaster (see table 47).

Table 47
Water and sanitation sector: gross revenues baseline, RyL
(Monetary units)

Description	Customers	Cost of service (month)	Total expected sales
Waste collection	38 400	100	46 080 000
Total			46 080 000

(c) The reduction in revenues is obtained by calculating the difference between the actual sales made by the firms after the disaster and the sales they would have expected under normal conditions (baseline) (see table 48).

Table 48
Water and sanitation sector: reduction in revenues from sales of water
(Monetary units)

	Water sold *(cubic metres per month)*	Time operating *(months)*	Price per cubic metre of water *(monetary units)*	Total sales after disaster
Plant 1	161 458	6	100	96 875 000
Plant 2	161 458	11	100	177 604 167
Plant 3	86 542	11	100	95 195 833
Plant 4	86 542	12	100	103 850 000
Total				473 525 000

The information presented in tables 46 and 48 indicates a reduction in the revenues of AyA from sales of water and sanitation services. The difference is estimated at 121,675,000 MUs (see table 49).

Table 49
Water and sanitation sector: reduction in revenues from waste collection
(Monetary units)

Description	Customers	Time operating *(months)*	Price of service *(monetary units)*	Total sales after disaster
Waste collection	38 400	11	100	42 240 000
Total	38 400			42 240 000

RyL was also affected by a reduction in revenues from sales of waste collection services. On the basis of the information supplied in tables 47 and 49, the decline is estimated at 3,840,000 MUs.

(d) The additional costs were met from three sources: the local government, AyA and international cooperation. The local government is responsible for providing tanker trucks and removing rubble from the area. The costs are estimated at 10,840,000 MUs. AyA has to cover the operating costs of the mobile plant for six months and purchase the chemicals needed to purify the water, estimated at 2,750,000 MUs. An international cooperation agency will cover the costs of providing water for six months, which come to 12 million MUs (see table 50).

Table 50
Water and sanitation sector: additional costs
(Monetary units)

Description	Quantity	Cost	Duration *(months)*	Total
Tanker trucks	31 700	50	4	6 340 000
Operation of mobile plant	1	450 000	6	2 700 000
Supply of water	12 500	160	6	12 000 000
Purification chemical	100	500	n.a.	50 000
Rubble removal	50 000	90	n.a.	4 500 000
Total				25 590 000

(e) The rebuilding process will involve improvements to the three plants affected by the disaster. According to the information available, it is estimated that the costs of rebuilding plants 1 and 2 will increase by 30% and those of rebuilding plant 3 by 25%. In addition, the equipment has to be imported, which raises its cost by 15% (see table 51). The estimation is based on the information presented in table 45.

Table 51
Water and sanitation sector: cost of rebuilding
(Monetary units)

Description	Replacement value	Increase when rebuilding *(percentages)*	Rebuilding value
Plant 1	800 000 000	30	1 040 000 000
Plant 2	476 000 000	30	618 800 000
Plant 3	412 500 000	25	515 625 000
Inventories	172 500 000	15	198 375 000
Total			2 372 800 000

Exercise 7: telecommunications

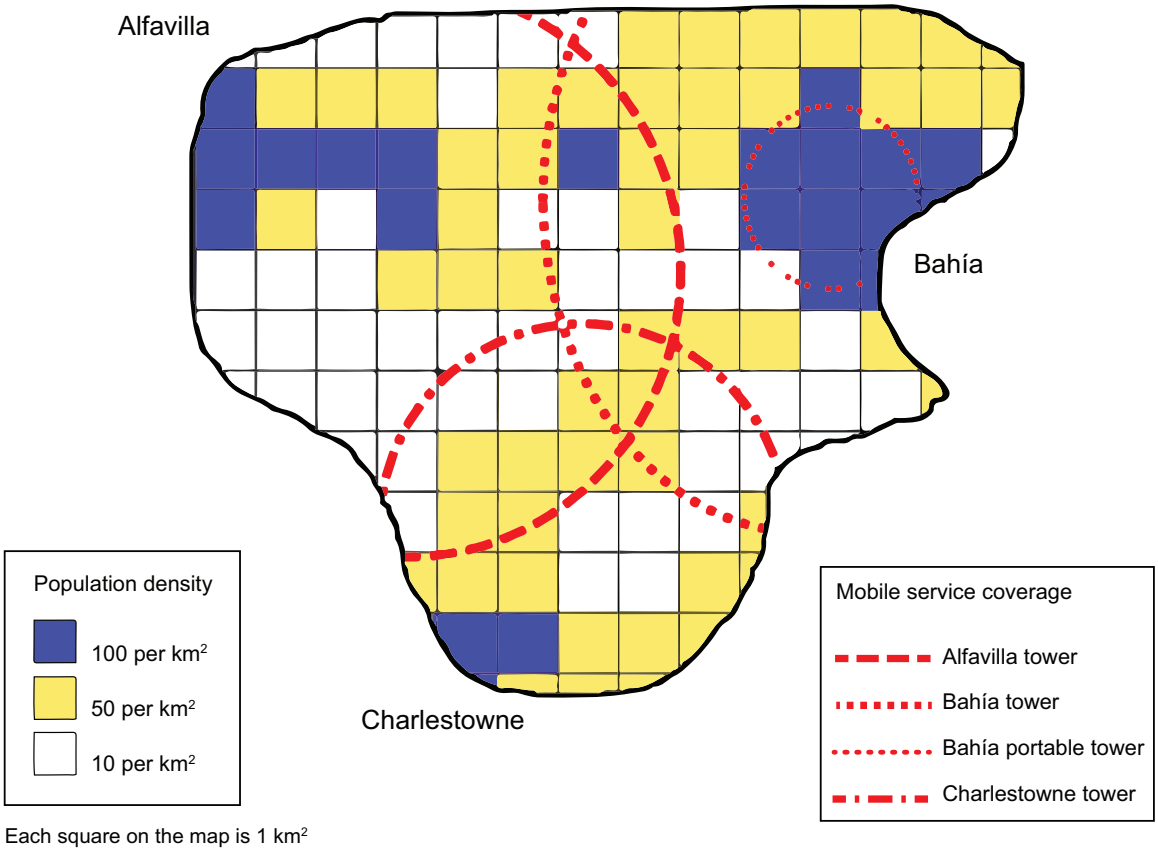
Triplocom island has a population of about 4,500 and was affected by a category 2 hurricane on 1 August. Mobile telephony services suffered impacts of various kinds in the island's three villages.

The mobile phone tower in Alfavilla suspended service because of an interruption to the power supply in the area. The towers are usually supplied by batteries and a generator, allowing them to carry on operating with their reserve energy during power cuts. However, the tower was recently attacked by vandals looking for electricity to power up their car audio system, which affected the batteries. The lack of reserve energy meant that the Alfavilla tower mobile phone service could not be restored until the village had access to mains electricity on the night of 4 August.

In the village of Bahía, the base transceiver station attached to the cell tower was damaged by wind and soaking that caused irreparable harm to the equipment. Mobile services were suspended from 1 August. As a temporary measure to restore the service, a portable cell tower was installed on 10 August. This has less capacity than the Bahía tower. Because coverage was limited to a smaller area, the service was restored only in the central area of Bahía. Outlying areas were left without service until the transceiver base station could be replaced on 30 August.

The assessment team obtained national statistics indicating that 75% of Triplocom residents use mobile phones. The telecommunications firm advised that its average revenue per user for mobile phone services was 100 MUs a month. A map of the island is presented below. Use it to estimate losses for the mobile telephony service (see map 2).

Map 2
Triplocom island



Answer

To estimate losses, it is necessary to know the number of users affected by the service interruption, the length of the interruption and its total value.

To determine the population affected, the number of people in each square is found and the cell tower serving this population identified. It is important to carry out adjustments to avoid double counting of populations served by more than one tower. For example, although some 2,030 people in Alfavilla lost their mobile phone service for four days, 320 of them were within range of the Charlestowne tower and so were not left without service. Consequently, it is estimated that some 1,710 people in Alfavilla completely lost their service after the storm.

The population affected in Alfavilla, i.e., 1,710 people, is then multiplied by the degree of service penetration, which national data put at 75%. Some 1,238 users are estimated to have been affected. The Alfavilla service was interrupted for four days. Multiplying the number of affected users, 1,238, by the length of the interruption, 4 days, yields a service loss of 5,130 mobile phone days. When average revenue per user (100 MUs) is divided by 30 days, each mobile phone day of service foregone is found to have a value of 3.33 MUs. The above information makes it possible to estimate the losses by multiplying the daily value of the service (3.33 MUs) by the number of mobile phone days foregone. The Alfavilla loss is thus determined to have been 17,100 MUs.

The same procedure is followed for the village of Bahía, which lost its mobile phone service for 10 days until the portable tower was set up, while outlying areas lost their service for 30 days. The loss from the interruption to the mobile phone service is estimated at 124,538 MUs.

The result of the population count may alter the final loss estimate. This difference reflects the reality and complexities of these types of estimates, whose accuracy depends directly on the quality of the information available in the country and sector. It is desirable for the information on the number of users to be obtained from the service provider itself and not through population counts. This exercise illustrates other procedures for producing and analysing information that can be used to corroborate data provided by the firm.

Exercise 8: electricity

The central area of a country was affected by a very strong earthquake on 1 January 2017. It has three hydroelectric plants that generate 50% of the country's electricity. Information collected from the electricity companies about the effects of the disaster on these installations yields the following findings:

(i) One hydroelectric plant was totally destroyed, with a replacement cost of 4,600 million MUs, of which 1,600 million MUs is for equipment. Because the area where it is located is so rugged, it would take five years to bring back into operation. The infrastructure requiring replacement has an imported component of 50%.

(ii) The infrastructure of two hydroelectric plants was slightly affected. The first has a replacement cost of 8,700 million MUs and presented damage in the diversion and storage dams worth 200 million MUs. The second has a replacement cost of 7,700 million MUs, with damage to channels, tunnels and pressure pipes worth 100 million MUs. The infrastructure requiring replacement has an imported component of 50%.

(iii) The imported component of the equipment for the destroyed plant is 85%.

(iv) The transmission system was also affected, with damage to 1,000 electricity pylons and poles and to 400 km of transmission grid valued at 81 million MUs and 19.7 million MUs, respectively. The imported component of the material required to make good the damage to the transmission grid is 80%.

(v) A total of 290 transformers with a unit cost of 4,000 MUs were destroyed in the distribution centres. Other equipment was valued at 65.2 million MUs. The imported component of the material required to make good the damage to the distribution centres is 90%.

(vi) 10,000 houses were destroyed by the earthquake, making it necessary to install household connections at a cost of 170 MUs apiece. The houses will be built in a year.

(vii) The exchange rate is 3 MUs per dollar.

(viii) The destroyed power plant had monthly sales of 23 million MUs.

To assess the disaster in the electrical sector:

(a) Estimate the baseline for damage in the sector.

(b) Estimate the damage caused by the earthquake.

(c) Estimate the impact on imports.

(d) Estimate the losses resulting from lower electricity consumption by residential consumers, assuming other groups do not reduce their consumption.

Answers

(a) The information obtained only serves to estimate the baseline for the hydroelectric plants (see table 52). Detailed information on these plants' different assets is not available. Accordingly, only an aggregate baseline will be presented. Furthermore, there is no information on the assets of the transmission and distribution system prior to the disaster. In an assessment, it is desirable for this information to be obtained.

Table 52
Electricity sector: baseline, hydroelectric plants
(Millions of monetary units)

Plant	Replacement cost
Hydroelectric plant 1	4 600
Hydroelectric plant 2	8 700
Hydroelectric plant 3	7 700
Total	21 000

(b) The damage estimation is carried out on the assets affected by the disaster for different agents in the electrical system.

(b.1) Hydroelectric plants. The report on the situation after the disaster can be used to estimate the damage to electrical plants by asset type. The damage to hydroelectric plants is estimated at 4.9 billion MUs (see table 53).

Table 53
Electricity sector: damage to hydroelectric plants
(Millions of monetary units)

Plant	Infrastructure	Equipment	Total
Hydroelectric plant 1	3 000	1 600	4 600
Hydroelectric plant 2	200	0	200
Hydroelectric plant 3	100	0	100
Total	3 300	1 600	4 900

(b.2) Damage to transmission systems, distribution centres and household connections. The estimates for damage to these assets are presented in tables 54 and 55. The estimated damage is 100.1 million MUs in the case of transmission systems and 66.4 million MUs in the case of distribution centres. Household connections are to be included in the housing sector, as they were a housing asset. As the *Handbook for Disaster Assessment* (2014) emphasizes, the assessment should be carried out as a totality. This damage can be estimated by the electricity sector specialist, but it must be discussed and registered with the housing sector specialist.

Table 54
Electricity sector: damage to transmission systems and distribution centres
(Millions of monetary units)

Description	Unit of measurement	Infrastructure and equipment	Unit cost	Value of damage
Transmission system				**100.7**
Electricity pylons and poles	Units	1 000		81
Transmission grids	Kilometres	400		19.7
Distribution centres				**66.4**
Transformers	Units	290	400	1.2
Other equipment	Units	-		65.2
Household connections	Units	10 000	170	**1.7**

Table 55
Housing sector: damage to household connections
(Millions of monetary units)

Description	Unit of measurement	Infrastructure and equipment	Unit cost	Value of damage
Household connections	Units	10 000	170	1.7

(b.3) Total damage. The damage is estimated at 5.0671 billion MUs (see table 56).

Table 56
Electricity sector: total damage
(Millions of monetary units)

Component	Value of damage
Infrastructure	4 900.0
Transmission system	100.7
Distribution centres	66.4
Total	5 067.1

(c) Imports will be estimated asset by asset, considering the information in tables 53 and 54, as follows:

- Infrastructure replacement requires 50% imported components. Consequently, the value of the imports required to replace infrastructure at the three hydroelectric plants is: 3,300,000,000 * 0.5 = 1,650,000,000 MUs.
- Replacement of equipment at the hydroelectric plants requires 85% imported components. The import value of the equipment is: 1,600,000,000 * 0,85 = 1,360,000,000 MUs.
- Replacement of transmission systems requires 80% imported components. The import value is therefore: 100,700,000 * 0.80 = 80,560,000 MUs.
- Replacement of distribution centres requires 90% imported components. The import value is therefore: 66,360,000 * 0.90 = 59,724,000 MUs.

- Replacement of transmission systems (household connections) requires 80% imported components. The import value is: 1,700,000 * 0.80 = 1,360,000 MUs.
- The exchange rate is 3 MUs per dollar.

The value of the imports required to replace damaged assets in the electricity sector is estimated at US$ 1.0501 billion (see table 57). Those required in the housing sector to replace electrical connections is US$ 453,000 (see table 58).

Table 57
Electricity sector: imports
(Millions of dollars)

Component	Imports
Infrastructure	1 003.3
Transmission system	26.9
Distribution centres	19.9
Total	1 050.1

Table 58
Housing sector: imports
(Dollars)

Component	Imports
Household connections	453 333
Total	453 333

(d) The average monthly sales of the destroyed plant (23 million MUs) are used to estimate losses for the current year. The result is a loss of 276 million MUs, which will be extended by a similar amount for a further four years.

III. The production sector

Exercise 9: tourism

An island country was affected by a hurricane on 31 October. There were three large hotels (each with over 149 rooms) on the island and 12 hotels with 10 rooms or less (see table 59).

Table 59
Number of rooms by hotel type

Large hotels	
Establishment	Number of rooms
Hotel 1	250
Hotel 2	150
Hotel 3	200
Small hotels	
Hotel 4	10
Hotel 5	8
Hotel 6	10
Hotel 7	9
Hotel 8	9
Hotel 9	9
Hotel 10	10
Hotel 11	9
Hotel 12	8
Hotel 13	8
Hotel 14	9
Hotel 15	9

Table 60 presents the information compiled by the assessment team for the impact on hotels and the timetable for bringing them back into operation.

Table 60
Hotel sector: damaged infrastructure

Establishment	Damage	Number of rooms	Replacement time
		Large hotels	
Hotel 2	Partial	45	1 year
Hotel 3	Partial	60	1 year
		Small hotels	
Hotel 4	Partial	8	2 years
Hotel 6	Partial	4	1 year
Hotel 7	Partial	8	2 years
Hotel 9	Partial	3	1 year
Hotel 10	Partial	9	2 years
Hotel 11	Partial	7	2 years

It is known that the high tourist season on the island begins on 1 December and ends on 30 March.

The Ministry of Tourism has provided the following information:

(i) The large hotels have an average occupancy rate of 80% in high season and 60% in low season; in both cases, 90% of occupancies are on an "all-inclusive" basis. In high season, average daily rates are approximately 7,000 MUs all inclusive and 5,000 MUs for lodging alone. Rates in low season are 4,000 MUs and 3,000 MUs, respectively.

(ii) The small hotels have an occupancy rate of 70% in high season and 50% in low season. Many of those using this type of service plan to go fishing, and in high season the hotels offer such guests packages costing 60,000 MUs a week. This type of demand accounts for a third of occupancy. If these services are not requested, the average daily room price, including meals, is 2,500 MUs. In low season, the prices are 45,000 MUs and 1,500 MUs.

(iii) According to the biannual survey, tourism-related activities account for some 5% of hotels' gross revenues.

The disaster assessment group also estimates the replacement cost per room at 34 million and 32 million MUs, respectively, for hotels 2 and 3. In the case of small hotels, the cost is 12 million MUs. Each room's furniture and equipment represents 5% of the total for the large hotels and 10% for the small hotels. The imported component of the materials required for replacement of both infrastructure and furniture is 60%.

On the basis of the information provided:

(a) Estimate the damage to each type of hotel. Estimate the value of the additional imports that will be required to make good this damage, if the exchange rate is 6 MUs per dollar.

(b) Estimate the percentage of the damage that was insured.

(c) Estimate the large hotels' gross revenue baseline for years 1 and 2.

(d) Estimate the gross revenues foregone by the large hotels in years 1 and 2.

(e) Estimate the small hotels' gross revenue baseline for years 1 and 2.

(f) Estimate the gross revenues foregone by the small hotels.

(g) Estimate the gross revenues foregone in other tourist activities for years 1 and 2.

(h) Summarize the damage and losses of total gross revenues in the tourism sector for years 1 and 2.

Answers

(a) Estimate the damage to each type of hotel (see table 61).

Table 61
Tourism sector: damage
(Millions of monetary units)

Establishment	Rooms	Infrastructure	Furniture	Total
		Large hotels		
Hotel 2	45	1 530 000 000	76 500 000	1 606 500 000
Hotel 3	60	1 920 000 000	96 000 000	2 016 000 000
Subtotal		3 450 000 000	172 500 000	3 622 500 000
		Small hotels		
Hotel 4	7	84 000 000	8 400 000	92 400 000
Hotel 6	3	36 000 000	3 600 000	39 600 000
Hotel 7	6	72 000 000	7 200 000	79 200 000
Hotel 9	3	36 000 000	3 600 000	39 600 000
Hotel 10	7	84 000 000	8 400 000	92 400 000
Hotel 11	7	84 000 000	8 400 000	92 400 000
Subtotal		396 000 000	39 600 000	435 600 000
Total		3 846 000 000	212 100 000	4 058 100 000

Total damage in the tourism sector is 4.058 billion MUs, with 89.3% of this being sustained by the large hotels. Note that the procedure was to estimate the damage directly. The baseline is given in table 59. In this case there is no need to differentiate between year 1 and year 2 because all the damage occurs in year 1. The estimated value of the imports required for replacement is US$ 405.8 million.

(b) Estimate the percentage of the damage that was insured.

On the assumption that only the assets of the large hotels were insured, the percentage of damage insured is 89.3%. From the point of view of policy after the disaster, this information is important to enable specific policies to be designed to contribute to the recovery of the small hotels.

(c) Estimate the gross revenue baseline for the large hotels.

The year 1 baseline will be the revenues that were expected in the last two months of the year. In that period, November is low season and December high season. In year 2, the estimate for the high season baseline covers the months of January, February, March and December, while the estimate for the low season baseline covers the months from April to November (see table 62).

Table 62
Tourism sector: large hotels, gross revenue baseline
(Millions of monetary units)

Year 1		
Establishment	Number of rooms	Gross revenues
High season		
Hotel 1	250	42 160 000
Hotel 2	150	25 296 000
Hotel 3	200	33 728 000
Subtotal		101 184 000
Low season		
Hotel 1	250	14 400 360
Hotel 2	150	8 640 216
Hotel 3	200	11 520 288
Subtotal		34 560 864
Total year 1		135 744 864
Year 2		
Establishment	Number of rooms	Gross revenues
High season		
Hotel 1	250	164 560 000
Hotel 2	150	98 736 000
Hotel 3	200	131 648 000
Subtotal		394 944 000
Low season		
Hotel 1	250	139 080 000
Hotel 2	150	83 448 000
Hotel 3	200	111 264 000
Subtotal		333 792 000
Total year 2		728 736 000

Average monthly revenues are 2.92 times as great in high season as in low season. In year 2, revenues for the four months of high season are 54.2% of the annual total. This is worth stressing, since the seasonality of revenues needs to be borne in mind when estimating the effects of a disaster in this sector.

(d) Estimate the gross revenues foregone by the large hotels.

The gross revenues foregone equal the difference between the baseline estimated in (c) and the revenues obtained in the situation subsequent to the disaster. This can be calculated directly, as table 60 gives information about the number of damaged rooms and the time it will take before they are ready for use again. Table 63 presents estimates for the situation subsequent to the disaster.

Table 63
Tourism sector: large hotels, gross revenues foregone
(Millions of monetary units)

Year 1		
Establishment	Number of rooms	Gross revenues
High season		
Hotel 2	45	7 588 800
Hotel 3	60	10 118 400
Subtotal		17 707 200
Low season		
Hotel 2	45	2 592 065
Hotel 3	60	3 456 086
Subtotal		6 048 151
Total year 1		23 755 351
Year 2		
Establishment	Number of rooms	Gross revenues
High season		
Hotel 2	45	22 032 000
Hotel 3	60	39 494 400
Subtotal		61 526 400
Low season		
Hotel 2	45	21 956 400
Hotel 3	60	33 379 200
Subtotal		55 335 600
Total year 2		116 862 000

Hotel 1 is not included in table 63 because it did not suffer any damage from the disaster and the implicit assumption is that its revenues will not be affected. In this hypothetical exercise, in other words, although the hotel is in a disaster area, the flow of tourists remains unaltered. According to the information obtained, restoring the assets of hotels 2 and 3 will take 12 months, meaning that they can operate normally from 1 November of year 2. For this reason, the estimate of gross revenues foregone in year 2 only includes the first 10 months of the year, three of them being high season and the other seven low season.

Gross revenues foregone in year 1 are estimated at 23.8 million MUs, with 74.5% of this amount being for the high season. For year 2, the figures are 116.9 million MUs and 52.7%, respectively.

(e) Estimate the gross revenue baseline for the small hotels (see table 64).

Table 64
Tourism sector: small hotels, gross revenue baseline
(Monetary units)

Year 1	Number of rooms	High season	Low season
Hotel 4	10	921 667	450 000
Hotel 5	8	737 333	360 000
Hotel 6	10	921 667	450 000
Hotel 7	9	829 500	405 000
Hotel 8	9	829 500	405 000
Hotel 9	9	829 500	405 000
Hotel 10	10	921 667	450 000
Hotel 11	9	829 500	405 000
Hotel 12	8	737 333	360 000
Hotel 13	8	737 333	360 000
Hotel 14	9	829 500	405 000
Hotel 15	9	829 500	405 000
Total year 1		9 954 000	4 860 000
Year 2	Number of rooms	High season	Low season
Hotel 4	10	3 791 667	3 845 000
Hotel 5	8	3 033 333	3 076 000
Hotel 6	10	3 791 667	3 845 000
Hotel 7	9	3 412 500	3 460 500
Hotel 8	9	3 412 500	3 460 500
Hotel 9	9	3 412 500	3 460 500
Hotel 10	10	3 791 667	3 845 000
Hotel 11	9	3 412 500	3 460 500
Hotel 12	8	3 033 333	3 076 000
Hotel 13	8	3 033 333	3 076 000
Hotel 14	9	3 412 500	3 460 500
Hotel 15	9	3 412 500	3 460 500
Total year 2		40 950 000	41 526 000

(f) Estimate the gross revenues foregone by the small hotels.

Using the table 60 information, and following a procedure similar to that employed to estimate the large hotels' losses, a figure was obtained for the profit foregone by the small hotels. Note that the estimate is for losses in years 1 and 2. Hotels 4, 7, 10 and 11 will forego profit for 10 months in year 3, but the exercise does not ask for that estimate (see table 65).

Table 65
Tourism sector: small hotels, gross revenues foregone
(Monetary units)

Year 1	Number of rooms	High season	Low season
Hotel 4	7	645 167	315 000
Hotel 6	3	276 500	135 000
Hotel 7	6	553 000	270 000
Hotel 9	3	276 500	135 000
Hotel 10	7	645 167	315 000
Hotel 11	7	645 167	315 000
Total year 1		3 041 500	1 485 000
Year 2	Number of rooms	High season	Low season
Hotel 4	7	2 654 167	2 691 500
Hotel 6	3	861 000	1 018 500
Hotel 7	6	2 275 000	2 307 000
Hotel 9	3	861 000	1 018 500
Hotel 10	7	2 654 167	2 691 500
Hotel 11	7	2 654 167	2 691 500
Total year 2		11 959 500	12 418 500

Gross revenues foregone in year 1 are estimated at 4.5 million MUs, with 67.2% of this pertaining to the high season. The numbers for year 2 are 24.4 million MUs and 49.1%, respectively.

(g) Estimate the gross revenues foregone in other tourist activities for years 1 and 2 (see table 66).

Table 66
Tourism sector: gross revenues foregone in activities connected to accommodation services
(Monetary units)

Establishment type	Year 1	Year 2
Large hotels	1 187 768	4 745 280
Small hotels	226 325	1 218 900
Total	1 414 093	5 964 180

The exercise provides information gathered in the country to the effect that revenues from other tourist activities amount to 5% of revenues in the accommodation business. This figure was used to estimate losses of gross revenues, amounting to 1.4 million MUs in year 1 and 6 million MUs in year 2.

(h) Summarize the total damage and gross revenues foregone in the tourism sector in years 1 and 2 (see table 67).

Because of when the disaster took place (late in the tenth month of year 1), most of the effects are concentrated in year 1. As is typical of these events, all the damage occurred in the first year. Where losses of gross revenues are concerned, 80.1% were in year 2 and 76.6% were incurred by the large hotels.

Table 67
Tourism sector: damage and gross revenues foregone
(Monetary units)

Year 1	Damage	Gross revenues foregone
Large hotels	3 622 500 000	23 755 351
Small hotels	435 600 000	4 526 500
Other activities		1 414 093
Total year 1	4 058 100 000	29 695 944
Year 2	Damage	Gross revenues foregone
Large hotels		94 905 600
Small hotels		24 378 000
Other activities		5 964 180
Total year 2		125 247 780

Exercise 10: fishing

A hurricane caused serious damage in the northern region of a country. Besides the damage done by the wind and precipitation, there was a storm surge that worsened the situation in the coastal area. Both commercial and recreational fishing have been affected. The team of disaster assessment specialists has collected the following information:

(i) The region had a small fishing dock with two wharfs and a building for preparing, packing and freezing catches. One of the wharfs was completely destroyed and the other affected to the extent of 50%. The roof of the building was destroyed and two industrial freezers being used to store processed products (about 800 kg of fish and 200 lobster tails) were damaged. The sea wall of the dock was 20% affected.

(ii) A dock with these characteristics costs 50 million MUs. The sea wall accounts for 40% of the cost, the building for 25% and the wharfs for 15%. The remaining 20% is for the other installations. The cost of replacing the roof of the building is 2.5 million MUs.

(iii) The cost of the damaged industrial freezers is 1.5 million MUs apiece. They are imported. The fish and processed lobsters represent a profit of 40% on the catch price. The new freezers are due to arrive in a month and a half.

(iv) The cost of removing the dock rubble is estimated at 2 million MUs. The work of collecting the rubble is expected to take two weeks and the repair work two and a half months once all the rubble has been removed.

(v) There was a fleet of 20 fishing boats that directly employed about 80 families. Of this fleet, 50% was totally destroyed, 30% sustained damage of 50% and the remainder sustained minor damage of about 20%.

(vi) The average cost of a fishing boat is 500,000 MUs. About 50% of this is for local components and the rest is for imports.

(vii) It is estimated that the repair of the vessels with minor damage (20%) will take less than a week. Repairing the vessels with 50% damage will take a month. The rest might be operational in two months.

(viii) Besides the damage to the vessels, 20% of the artificial pens used to catch lobsters were destroyed. There are estimated to be a total of 50 of these pens for each boat. The replacement cost is 1,000 MUs.

(ix) It is estimated that each boat makes about 20 fishing trips in these months, catching an average of 18 lobsters and 50 kg of fish. The price of each lobster is 30 MUs, while a kilogram of fish is worth 20 MUs.

(x) The region has three lodgings catering for recreational fishing. Each has two guides with their respective boats. One of these establishments was completely destroyed and the other two sustained 50% damage.

(xi) Each lodging costs 15 million MUs. It is estimated that those which have sustained partial damage can be operational again in three months, whereas rebuilding the one that was totally written off will take a year. The cost of equipping each lodging is estimated at 40% of the value of the building. Damage to the equipment is proportional to the structural damage.

(xii) Four of the recreational fishing boats sustained 50% damage and two were completely destroyed. The boats cost 400,000 MUs apiece and are imported. The destroyed boats can be replaced in two months, while those with 50% damage can be operational in a month. The lodging that was totally written off also lost its two boats.

(xiii) Each day of recreational fishing is estimated to generate revenue of 6,000 MUs per boat, and in those months of the year the occupancy rate is 75%. Given the conditions in the region, accommodation is necessary for the service to be provided. Fishermen forego an average 10% tip.

(xiv) No one connected with the fishing business considers the hurricane to have adversely affected marine species.

(xv) The exchange rate is 15 MUs per dollar.

On the basis of the information provided:

(a) Estimate the baseline for the damage.

(b) Estimate the total damage. What percentage of that damage involves imported components? Estimate the impact on imports.

(c) The height of the sea wall needs to be increased to mitigate future damage to the fishing dock. The cost of this improvement is estimated at 30% of the original value of the sea wall. Furthermore, the plan is also to replace the industrial freezers with more energy-efficient ones. Each new refrigerator is 50% more expensive than the replacement cost originally estimated. The intention is also to make improvements to the furniture and equipment of the lodging that was completely destroyed, worth 10% on top of the cost originally estimated. Estimate these additional costs and the total replacement cost.

(d) Estimate the baseline for the commercial and recreational fishing losses.

(e) Estimate losses over the next six months in commercial and recreational fishing. Bear in mind that this activity cannot be carried out unless the dock becomes operational.

(f) What is the total value of the damage, losses and other costs inflicted by this disaster on the region's fishing activity? Compare this with the sector's output in a year.

(g) The government is securing a donation of a refrigerator truck and equipping a nearby wharf for unloading. Both will be operational in 30 days. Estimate the impact on losses.

Answers

(a) The baseline for the calculations is presented in tables 68 and 69. The baseline is 95 million MUs for the affected infrastructure, 21 million MUs for equipment and 13.4 million MUs for boats and other assets. In total, the baseline for the calculations is 129.4 million MUs.

Table 68
Fishing sector: baseline for fixed assets and equipment
(Monetary units)

Establishment	Infrastructure	Equipment	Total
Fishing dock	50 000 000	3 000 000	53 000 000
Sea wall	20 000 000		20 000 000
Wharfs	7 500 000		7 500 000
Building	12 500 000	3 000 000	15 500 000
Other	10 000 000		10 000 000
Lodgings	45 000 000	18 000 000	63 000 000
Lodging A	15 000 000	6 000 000	21 000 000
Lodging B	15 000 000	6 000 000	21 000 000
Lodging C	15 000 000	6 000 000	21 000 000
Total	95 000 000	21 000 000	116 000 000

Table 69
Fishing sector: baseline for boats and other assets
(Monetary units)

	Quantity	Unit value	Total value
Commercial fishing			
Boats	20	500 000	10 000 000
Artificial pens	1 000	1 000	1 000 000
Recreational fishing			
Boats	6	400 000	2 400 000
Total			13 400 000

(b) Infrastructure damage is presented in table 70. Damage to the fishing dock totals almost 12.2 million MUs, while damage to lodgings for recreational fishing is 30 million MUs. Total infrastructure damage is 42.1 million MUs.

Table 70
Fishing sector: infrastructure damage
(Monetary units)

Establishment	Quantity	Infrastructure valuation	Value of infrastructure damage
Fishing dock		50 000 000	12 125 000
Sea wall	1	20 000 000	4 000 000
Wharfs	2	7 500 000	5 625 000
Building	1	12 500 000	2 500 000
Other		10 000 000	
Lodgings	3	45 000 000	30 000 000
Lodging A		15 000 000	15 000 000
Lodging B		15 000 000	7 500 000
Lodging C		15 000 000	7 500 000
Total		95 000 000	42 125 000

Equipment damage is presented in table 71. Total damage to this type of asset is 15 million MUs, of which 3 million MUs is to the freezers and the other 12 million MUs to furniture and equipment.

Table 71
Fishing sector: equipment damage
(Monetary units)

Equipment	Quantity	Equipment valuation	Value of equipment damage
Freezers	2	3 000 000	3 000 000
Furniture and equipment		18 000 000	12 000 000
Lodging A		6 000 000	6 000 000
Lodging B		6 000 000	3 000 000
Lodging C		6 000 000	3 000 000
Total		21 000 000	15 000 000

The rest of the damage was to boats and fishing equipment. Damage to commercial vessels is 6.9 million MUs, while damage to recreational fishing vessels totals 1.6 million MUs. In addition, 200 artificial lobster pens were damaged. Damage of this type is estimated at 200,000 MUs. Damage to boats and other assets totals 8.7 million MUs (see table 72).

Table 72
Fishing sector: damage to boats and other assets
(Monetary units)

Type	Quantity	Valuation	Value of damage
Commercial vessels	20	10 000 000	6 900 000
Commercial fishing equipment	1 000	1 000 000	200 000
Recreational fishing vessels	6	2 400 000	1 600 000
Total		13 400 000	8 700 000

Table 73 presents a summary of the damage caused by the disaster. The damage totals 65.8 million MUs. Of the total damage, 8.8 million MUs is estimated to affect assets that will have to be imported. At the current exchange rate, this amounts to US$ 536,667.

Table 73
Fishing sector: damage summary
(Monetary units)

	Infrastructure	Equipment	Boats and other equipment	Total value of damage
Fishing dock	12 125 000	3 000 000		15 125 000
Sea wall	4 000 000			4 000 000
Wharfs	5 625 000			5 625 000
Building	2 500 000	3 000 000		5 500 000
Other				0
Lodgings	30 000 000	12 000 000		42 000 000
Lodging A	15 000 000	6 000 000		21 000 000
Lodging B	7 500 000	3 000 000		10 500 000
Lodging C	7 500 000	3 000 000		10 500 000

Table 73 (concluded)

	Infrastructure	Equipment	Boats and other equipment	Total value of damage
Commercial vessels			6 900 000	6 900 000
Commercial fishing equipment			200 000	200 000
Recreational fishing vessels			1 600 000	1 600 000
Total	42 125 000	15 000 000	8 700 000	65 825 000

(c) Table 74 presents damage and rebuilding costs. The improvements to the sea wall require an extra 6 million MUs and those to the freezers an extra 1.5 million MUs. The improvements to the furniture and equipment in lodging A involve additional costs of 600,000 MUs. In total, they require additional spending of 8.1 million MUs.

Table 74
Fishing sector: rebuilding cost
(Monetary units)

Item	Total value of damage	Rebuilding costs	Total costs
Fishing dock	15 125 000	7 500 000	22 625 000
Sea wall	4 000 000	6 000 000	10 000 000
Wharfs	5 625 000		5 625 000
Building (freezers)	5 500 000	1 500 000	7 000 000
Other	0		0
Lodgings	42 000 000	600 000	42 600 000
Lodging A	21 000 000	600 000	21 600 000
Lodging B	10 500 000		10 500 000
Lodging C	10 500 000		10 500 000
Commercial vessels	6 900 000		6 900 000
Commercial fishing equipment	200 000		200 000
Recreational fishing vessels	1 600 000		1 600 000
Total	65 825 000	8 100 000	73 925 000

(d) The baseline for calculating commercial fishing losses is presented in table 75. The total value of this activity over the coming six months had the disaster not occurred is estimated at 3,696,000 MUs. Of this total, 2,400,000 MUs pertain to fish and 1,296,000 MUs to lobster catches.

Table 75
Fishing sector: baseline for commercial fishing losses
(Monetary units)

Commercial fishing	Actual days' fishing	Average daily catch *(kilograms and units)*	Price per kilogram or unit	Value of daily catch	Value of monthly catch	Total value *(six months)*
Fish	20	1 000	20	20 000	400 000	2 400 000
Lobster	20	360	30	10 800	216 000	1 296 000
Total				30 800	616 000	3 696 000

Table 76 shows the recreational fishing baseline for the next six months in the absence of the disaster. Total revenues from this activity would have been 2,732,400 MUs.

Table 76
Fishing sector: baseline for recreational fishing losses
(Monetary units)

Recreational fishing	Actual days' fishing	Daily cost	Tips	Daily revenues	Monthly revenues	Total revenues *(six months)*
Fishing with guide and boat						
Lodging A	23	6 000	600	6 600	151 800	910 800
Lodging B	23	6 000	600	6 600	151 800	910 800
Lodging C	23	6 000	600	6 600	151 800	910 800
Total				19 800	455 400	2 732 400

The baseline for losses in the fishing sector is 6.5 million MUs and includes frozen fish. The value of this fish is taken as a loss, as its amount represents about one day's catch for the whole fleet, and it would probably have been sold one or two days after the disaster (see table 77).

Table 77
Fishing sector: baseline for total fishing losses
(Monetary units)

Business	Value
Commercial fishing	3 696 000
Recreational fishing	2 732 400
Processed fish	30 800
Total	6 459 200

(e) To be able to estimate commercial fishing losses, it is necessary to evaluate how the sector's capacity will recover over time (see table 78). In this case, it is essential to restore the fishing dock, and this is only achieved after a period of three months. By that time, it is estimated that both the fleet and the freezers will be operational. Table 79 shows monthly losses calculated by the constraint on capacity. In total, there are three months of lost revenues totalling 1.85 million MUs.

Table 78
Fishing sector: commercial fishing constraints and capacity

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Dock operational						
Fleet operational	4	10	20	20	20	20
Freezers						

Table 79
Fishing sector: commercial fishing losses
(Monetary units)

Commercial fishing	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Total
Fish	400 000	400 000	400 000	0	0	0	1 200 000
Lobster	216 000	216 000	216 000	0	0	0	648 000
Total	616 000	616 000	616 000	0	0	0	1 848 000

Similarly, estimating recreational fishing losses requires an evaluation of how the sector's capacity recovers. Table 80 shows this information. The first thing that can be appreciated is that the fleet recovers before accommodation does. Nonetheless, the latter is necessary for the activity to take place. Recreational fishing capacity recovers only in the fourth month, and then only partially. Total losses in the recreational fishing sector over the next six months, totalling 1.8 million MUs, are presented in table 81.

Table 80
Fishing sector: recreational fishing constraints and capacity

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Lodging A						
Fleet A	0	0	2	2	2	2
Lodging B						
Fleet B	0	2	2	2	2	2
Lodging C						
Fleet C	0	2	2	2	2	2

Table 81
Fishing sector: recreational fishing losses
(Monetary units)

Recreational fishing	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Total
Lodging A	151 800	151 800	151 800	151 800	151 800	151 800	910 800
Lodging B	151 800	151 800	151 800	0	0	0	455 400
Lodging C	151 800	151 800	151 800	0	0	0	455 400
Total	455 400	455 400	455 400	151 800	151 800	151 800	1 821 600

Total losses in the sector are presented in table 82. The amount of losses in the next six months is 3.7 million MUs.

Table 82
Fishing sector: total losses
(Monetary units)

Description	Losses
Commercial fishing (including processed fish)	1 878 800
Recreational fishing	1 821 600
Total	3 700 400

(f) Total losses, damage and additional costs are presented in table 83. Losses, damage and additional costs represent five and a half times this activity's annual revenues.

Table 83
Fishing sector: damage, losses and other costs
(Monetary units)

Activity	Damage	Losses	Additional costs
Commercial fishing	22 225 000	1 878 800	2 000 000
Recreational fishing	43 600 000	1 821 600	0
Total	65 825 000	3 700 400	2 000 000

(g) The refrigerator truck donated and the wharf fitted out enable much of the commercial fleet to recommence activities in the second month and the remainder in the third month. The loss of revenues is reduced by 954,800 MUs (see table 84).

Table 84
Fishing sector: losses after the donation and the fitting out of the wharf
(Monetary units)

Description	Difference in losses
Original	1 878 800
With donation and wharf	924 000
Difference	954 800

Exercise 11: livestock

Suppose there to have been heavy rain followed by flooding in early January 2016 in province 1 of a country, the only one where cattle are reared and fattened. The local abattoir is also the only one in the country. Preliminary reports indicate that 400,000 head of cattle perished as a result of the event.

To construct the baseline, the group estimating the effects on the agricultural and livestock sector collects the following information on cattle stocks in 2011-2015 (see table 85).

Table 85
Cattle sector: general information
(Millions of head of cattle)

Year	Stock	Slaughtered
2011	5.4	1.4
2012	5.5	1.3
2013	5.6	1.4
2014	5.6	1.5
2015	5.4	1.45

From the latest agricultural census, held in 2013, it is known that:

(i) The composition of the livestock was as follows: 66.7% female and 33.3% male. The composition of the females is as follows: 20% calves (animals aged between 0 and 14 months), 20% heifers (animals aged between 14 and 30 months) and 60% cows (animals aged over two and a half years). The composition of the males is as follows: 33% calves (animals aged between 0 and 14 months), 37% bullocks (animals aged between 14 and 30 months) and 30% bulls (animals aged over two and a half years).

(ii) There are two types of farms: (a) small, accounting for 95.5% of producers and 35% of the country's livestock, and (b) large, accounting for 4.5% of producers and owning 65% of the animals.

(iii) At the time of the disaster, the average price per kilogram of meat was 3 MUs at the farm gate, 12 MUs ex-abattoir and 18 MUs to the consumer.

(iv) It is also known that the slaughtering yield is 50% (proportion of the animal's weight that is converted into meat for sale).

(v) In 2013, the average weight of animals by sex and age group was as shown in table 86.

Table 86
Cattle sector: average herd weight by age group and sex
(Kilograms)

Sex	Calves	Heifers and bullocks	Cows and bulls
Female	225.0	380	443.5
Male	257.7	460	595.6

With the information provided:

(a) Estimate the damage by farm type. Describe the assumption used to estimate it.

(b) Estimate the GPV foregone by farmers as a result of the disaster. Estimate the GPV foregone by farm type. Discuss the assumption used to estimate these.

(c) Estimate the GPV of the local abattoir.

(d) Estimate the GPV of the commerce sector.

(e) Because of dietary changes during the floods and the energy expended in moving, the average weight of each animal slaughtered is estimated to have fallen by an average of 10% over six months. Estimate farmers' GPV given this decline in yield.

(f) Estimate the total GPV foregone by farms.

Answers

(a) The first step in estimating the damage is to determine the number of animals that died before they were of an age for slaughter: calves, heifers and bullocks. In this case, the information from the second column of table 85 was used. Specifically, the starting assumption was that the population structure of the animals that perished matched the overall population structure at the time of the event. To calculate this figure, the total number of dead animals was prorated by the percentages that would potentially not be slaughtered that year (see table 87, third and fourth columns). Note that, of the 400,000 dead animals, about half were not of an age to be slaughtered.

Table 87
Livestock sector: dead animals by age and sex
(Thousands of head)

Sex	Total	Calves	Heifers and bullocks	Cows and bulls
Females	266.8	53.4	53.4	160.1
Males	133.2	44.0	49.3	40.0
Total	400.0	97.3	102.6	200.0

In a second step, the table 87 estimates were multiplied by the average number of kilograms these animals weighed and by the farm gate price of a kilogram of meat (see table 88). The value of the damage is 199 million MUs. Of this, about 66 million MUs was sustained by small farms and 129 million MUs by large farms. This number was estimated on the assumption that the deaths of animals matched the pattern of ownership by farm type.

Table 88
Livestock sector: damage
(Thousands of monetary units)

Sex	Total	Calves	Heifers and bullocks
Female	96 848	36 018	60 830
Male	101 994	33 982	68 012
Total	198 843	70 000	128 842

(b) The GPV foregone by farms was estimated using the same assumptions as for damage, but applying them to animals that were potentially going to be slaughtered: bulls and cows (see table 89).

Table 89
Livestock sector: gross production value foregone, by animals lost
(Thousands of monetary units)

Type	GPV
Cows	212 986
Bulls	71 401
Total	284 387

The GPV foregone is estimated at some 284 million MUs. Of this, 99.5 million MUs was foregone by small farms and 184.9 million MUs by large farms.

(c) The GPV foregone by abattoirs is to be registered in the manufacturing sector, as this is where it is classified by the System of National Accounts. Net kilograms of meat were estimated. To this end, the slaughtering yield rate of 50% and the price of 12 MUs per kilogram of meat produced by the abattoir were applied to the number of kilograms of cattle at the farm gate. Estimated GPV is about 568.8 million MUs (see table 90).

Table 90
Manufacturing sector: gross production value foregone, by animals lost
(Thousands of monetary units)

Type	GPV
Cows	425 973
Bulls	142 801
Total	568 774

(d) The GPV foregone in meat sales is to be recorded under the commerce sector. The only difference between this estimate and the abattoir estimate is that in this case a consumer selling price for the meat of 18 MUs/kg is applied. The GPV foregone by the commerce sector is 640.2 million MUs (see table 91).

Table 91
Commerce sector: gross production value foregone, by animals lost
(Thousands of monetary units)

Type	GPV
Cows	425 973
Bulls	214 202
Total	640 174

This exercise is a very good illustration of an aspect discussed in the *Handbook for Disaster Assessment* (2014): adding up the GPV foregone may involve double counting. In this example, it needs to be borne in mind that the commerce sector's GPV already includes the GPV foregone by the abattoir, which itself includes some of the GPV foregone by farms. To arrive at losses, the right approach would be to weight each of the estimated GPVs by the technical coefficients for each sector and then carry out the aggregation.

(e) The GPV foregone was estimated by assuming that as many animals would be slaughtered in 2016 as in 2015 (1.45 million head of cattle) and subtracting from this the number of animals perishing in the disaster that would have been slaughtered in 2016 (200,000 head of cattle), as estimated in the answer to question (b). Accordingly, the estimate is based on the figure of 1.25 million head of cattle. The next step used the information on the average weight loss and the portion of the year this lasted for. As in the answer to question (b), it was assumed that this weight loss affected cows and bulls alike and that the sex structure of the animals slaughtered would match that of the overall population (see table 92).

Table 92
Livestock sector: gross production value foregone, by drop in yield
(Thousands of monetary units)

Type	GPV
Cows	55 463
Bulls	37 187
Total	92 650

The GPV foregone is 92.7 million MUs. Of this figure, 32.5 million MUs was foregone by small farms and 60.2 million MUs by large farms.

(f) The total GPV foregone in the livestock sector is about 377 million MUs (see table 93). Note that this figure is for 2016. There is no additional information that would enable these estimates to be extended to subsequent years.

Table 93
Livestock sector: total gross production value foregone
(Thousands of monetary units)

Description	GPV
Due to loss of animals	284 387
Due to loss of yield	92 650
Total	377 037

Exercise 12: agriculture

The heavy rains from December to March led to major flooding in region A of a country. The government prepared a preliminary report on the effects of the disaster in the agricultural sector. The most salient details are set out below:

(i) A total of 30,000 ha was affected, of which 70% was given over to temporary crops.

(ii) The composition of the temporary crops impacted is as follows: rice, 35%; maize, 17%; potatoes, 9%; beans, 17%; vegetables, 22%. For permanent crops, the information is: sugar cane, 40%; grapes, 15%; mangos, 15%; bananas, 30%.

(iii) Across all crops, 45% of the land area sown was flooded, with the consequent destruction of the plants, while the remining 55% was affected by changes in humidity and hours of sunlight, resulting in lower yields.

(iv) The drop in yields was 5% for temporary crops and 2% for permanent crops.

(v) Additionally, 12 km of irrigation channels were totally destroyed, the replacement value being 1 million MUs per linear kilometre.

(vi) The cost of cleaning up plant residues is 1,000 MUs per hectare affected.

(vii) The exchange rate is 3.5 MUs per dollar.

(viii) Prices and yields per crop type are presented in table 94.

Table 94
Agricultural sector: yields and prices by crop type

Crop	Area sown *(hectares)*	Average yield *(metric tons per hectare)*	Producer price *(monetary units per hectare)*	Exports *(percentages)*
Rice	30 000	10	995	5
Maize	15 000	9	689	10
Potatoes	15 000	12	503	-
Beans	7 000	7.5	2 764	3
Vegetables	6 000	12.3	834	-
Sugar cane	60 000	90	317	-
Grapes	7 000	9.7	1 200	69
Mangos	13 000	14.1	850	70
Bananas	2 500	13.2	717	90

On the basis of the information provided:

(a) Estimate the damage.

(b) Estimate the monetary value of losses to temporary crops.

(c) Estimate the monetary value of losses to permanent crops.

(d) Estimate the monetary value of total losses per crop.

(e) Estimate the additional costs per crop.

(f) Estimate the impact on agricultural exports by crop type.

Answers

(a) Infrastructure damage can be estimated from the information supplied. It is known that 12 km of irrigation channels were destroyed and that the replacement value is 1 million MUs per linear kilometre, so that the value estimated for the damage is 12 million MUs. The information supplied emphasizes that no plants or trees were damaged, so no damage has to be estimated for this.

(b) To estimate losses of temporary crops, those that went unharvested will be separated from those whose yields fell. To begin with crops that went unharvested, the procedure will be as follows. First, the number of hectares affected will be estimated for each crop that could not be harvested. The information in points (i), (ii) and (iii) of the exercise will be used for this (see table 95). The surface area of temporary crops that go unharvested is estimated at 9,450 ha.

Table 95
Agricultural sector: hectares of temporary crops going unharvested

Crop type	Hectares affected *(percentages)*	Hectares going unharvested *(percentages)*	Composition of impact *(percentages)*	Area affected *(hectares)*
Rice	70	45	35	3 308
Maize	70	45	17	1 607
Potatoes	70	45	9	851
Beans	70	45	17	1 607
Vegetables	70	45	22	2 079
Total				9 450

In a second step, the production volume for each crop is obtained by multiplying the affected area of that crop by the average yield per hectare (see table 96).

Table 96
Agricultural sector: production foregone because temporary crops could not be harvested

Crop type	Area affected *(hectares)*	Average yield *(metric tons per hectare)*	Production volume foregone *(metric tons)*
Rice	3 308	10	33 075
Maize	1 607	9	14 459
Potatoes	851	12	10 206
Beans	1 607	7.5	12 049
Vegetables	2 079	12.3	25 572
Total	9 450		

The third step is to multiply the production volume foregone for each crop by its producer price. This gives an estimate of the GPV foregone for temporary crops that cannot be harvested. This GPV is 102.6 million MUs (see table 97).

Table 97
Agricultural sector: losses from temporary crops going unharvested
(Monetary units)

Crop type	Production volume foregone *(metric tons)*	Producer price *(monetary units per metric ton)*	Gross production value foregone
Rice	33 075	995	32 909 625
Maize	14 459	689	9 961 907
Potatoes	10 206	503	5 133 618
Beans	12 049	2 764	33 302 745
Vegetables	25 572	834	21 326 798
Total			102 634 692

A similar procedure was followed for temporary crop losses resulting from a decline in yields. First, the information in (i), (ii) and (iii) was used to estimate the number of hectares affected for each crop presenting a drop in yield (see table 98). The estimated area of temporary crops presenting a decline in yields is 11,550 ha.

Table 98
Agricultural sector: hectares of temporary crops presenting a decline in yields

Crop type	Hectares affected *(percentages)*	Hectares presenting a decline in yields *(percentages)*	Composition of impact *(percentages)*	Area affected *(hectares)*
Rice	70	55	35	4 043
Maize	70	55	17	1 964
Potatoes	70	55	9	1 040
Beans	70	55	17	1 964
Vegetables	70	55	22	2 541
Total				11 550

The second step is to multiply the affected area of each crop by the decline in its average yield per hectare with a view to obtaining the volume of production. This decline is 5% for temporary crops and 2% for permanent crops (see table 99).

Table 99
Agricultural sector: temporary crop production volume foregone because of lower yields

Crop type	Area affected *(hectares)*	Average yield *(metric tons per hectare)*	Production volume foregone *(metric tons)*
Rice	4 043	9.50	2 021
Maize	1 964	8.55	884
Potatoes	1 040	11.40	624
Beans	1 964	7.13	736
Vegetables	2 541	11.69	1 563
Total	11 550		

The third step is to multiply the production volume foregone for each crop by its producer price. This gives an estimate of GPV foregone for temporary crops because of lower yields. This loss of GPV totals 6.3 million MUs (see table 100).

Table 100
Agricultural sector: temporary crops, losses from lower yields

Crop type	Production volume foregone *(metric tons)*	Producer price *(monetary units per metric ton)*	Gross production value foregone *(monetary units)*
Rice	2 021	995	2 011 144
Maize	884	689	608 783
Potatoes	624	503	313 721
Beans	736	2 764	2 035 168
Vegetables	1 563	834	1 303 304
Total			6 272 120

(c) As was done with temporary crops, losses for permanent crops will be arrived at by separately estimating losses for crops that go unharvested from those caused by a decline in yields. To begin with unharvested crops, table 101 gives estimates of the area affected for each. The area on which permanent crops could not be harvested is estimated at 4,050 ha.

Table 101
Agricultural sector: hectares of permanent crops going unharvested

Crop type	Hectares affected *(percentages)*	Hectares going unharvested *(percentages)*	Composition of impact *(percentages)*	Area affected *(hectares)*
Sugar cane	30	45	40	1 620
Grapes	30	45	15	608
Mangos	30	45	15	608
Bananas	30	45	30	1 215
Total				4 050

The second step is to multiply the area affected by the average yield per hectare to obtain the production volume for each crop (see table 102).

Table 102
Agricultural sector: production volume foregone because of permanent crops going unharvested
(Metric tons)

Crop type	Area affected *(hectares)*	Average yield *(metric tons per hectare)*	Production volume foregone *(metric tons)*
Sugar cane	1 620	10	16 200
Grapes	608	9	5 468
Mangos	608	12	7 290
Bananas	1 215	7.5	9 113
Total	4 050		

The third step is to multiply the production volume foregone for each crop by its producer price. This gives an estimate of GPV foregone for permanent crops that cannot be harvested. This estimate is 24.4 million MUs (see table 103).

Table 103
Agricultural sector: losses from permanent crops going unharvested
(Monetary units)

Crop type	Production volume foregone *(metric tons)*	Producer price *(monetary units per metric ton)*	Gross production value foregone
Sugar cane	16 200	317	5 135 400
Grapes	5 468	1 200	6 561 000
Mangos	7 290	850	6 196 500
Bananas	9 113	717	6 533 663
Total			24 426 563

A similar procedure was followed for losses to permanent crops because of a decline in yields. First, the information in (i), (ii) and (iii) was used to estimate the number of hectares of each crop suffering a decline in yield (see table 104). The estimated area of permanent crops presenting a decline in yields is 4,951 ha.

Table 104
Agricultural sector: hectares of permanent crops presenting a decline in yields

Crop type	Hectares affected *(percentages)*	Hectares presenting a decline in yields *(percentages)*	Composition of impact *(percentages)*	Area affected *(hectares)*
Sugar cane	30	55	40	1 980
Grapes	30	55	15	743
Mangos	30	55	15	743
Bananas	30	55	30	1 485
Total				4 951

The second step is to multiply the affected area by the decline in average yield per hectare for each crop to obtain its production volume (see table 105).

Table 105
Agricultural sector: permanent crop production volume foregone because of lower yields
(Metric tons)

Crop type	Area affected *(hectares)*	Average yield *(metric tons per hectare)*	Production volume foregone *(metric tons)*
Sugar cane	1 980	9.80	396
Grapes	743	8.82	134
Mangos	743	11.76	178
Bananas	1 485	7.35	223
Total	4 951		

The third step is to multiply the production volume foregone for each crop by its producer price. This gives an estimate of the loss of GPV for permanent crops because of lower yields. This estimate is 597,094 MUs (see table 106).

Table 106
Agricultural sector: permanent crop losses due to lower yields
(Monetary units)

	Production volume foregone *(metric tons)*	Producer price *(monetary units per metric ton)*	Gross production value foregone
Sugar cane	396	317	125 532
Grapes	134	1 200	160 380
Mangos	178	850	151 470
Bananas	223	717	159 712
Total			597 094

(d) The estimate for total losses in the agricultural sector is 133.9 million MUs (see table 107). This is the type of summary table usually presented in agricultural sector assessments.

Table 107
Agricultural sector: losses
(Monetary units)

Crop type	Loss of harvest	Low yield	Total
Temporary	**102 634 692**	**6 272 120**	**108 906 812**
Rice	32 909 625	2 011 144	34 920 769
Maize	9 961 907	608 783	10 570 690
Potatoes	5 133 618	313 721	5 447 339
Beans	33 302 745	2 035 168	35 337 913
Vegetables	21 326 798	1 303 304	22 630 102
Permanent	**24 426 563**	**597 094**	**25 023 656**
Sugar cane	5 135 400	125 532	5 260 932
Grapes	6 561 000	160 380	6 721 380
Mangos	6 196 500	151 470	6 347 970
Bananas	6 533 663	159 712	6 693 374
Total	127 061 255	6 869 214	133 930 469

(e) The additional costs need to be estimated by using the estimates for the number of hectares on which temporary crops (column 5, table 95) or permanent crops (column 5, table 101) went unharvested because these were the hectares flooded. In addition, there is information that the average cost of cleaning up plant residues is 1,000 MUs per hectare. The additional costs are estimated at 13.5 million MUs (see table 108).

Table 108
Agricultural sector: additional costs
(Monetary units)

Crop type	Hectares flooded	Additional costs *(monetary units)*
Temporary		
Rice	3 308	3 308 000
Maize	1 607	1 607 000
Potatoes	851	851 000
Beans	1 607	1 607 000
Vegetables	2 079	2 079 000
Permanent		
Sugar cane	1 620	1 620 000
Grapes	608	608 000
Mangos	608	608 000
Bananas	1 215	1 215 000
Total		13 503 000

(f) The decline in external sales is estimated by taking: the estimates in the fourth column of table 107, the information in table 94 on the percentage of production by crop type that is exported, and the exchange rate. The drop in this variable in the agricultural sector is US$ 5.4 million (see table 109).

Table 109
Agricultural sector: drop in exports
(Dollars)

Crop type	Drop in exports
Temporary	
Rice	498 868
Maize	302 020
Potatoes	0
Beans	302 896
Vegetables	0
Permanent	
Sugar cane	0
Grapes	1 325 072
Mangos	1 269 594
Bananas	1 721 153
Total	5 419 604

The Economic Commission for Latin America and the Caribbean (ECLAC) pioneered not only disaster assessment but also compilation of the necessary methodology and courses on this methodology for member countries and international institutions. Its first disaster assessment was in 1973, following the Managua earthquake of December 1972. Since then, ECLAC has led some 100 disaster assessments in 28 countries of the region.

The experience of ECLAC in this area has been presented in three editions of the *Handbook for Disaster Assessment*, in 1991, 2003 and 2014. The last of these was prepared in collaboration with the Pan American Health Organization (PAHO). The present publication contains exercises developed for the economic, social and environmental disaster assessment methodology courses and is a teaching supplement to the third edition of the *Handbook*, which has been widely used in national and regional courses since its publication.

The purpose of this exercise guide is to reinforce the basic concepts used in estimating the effects of a disaster, namely damage, losses and additional costs, which are defined in the third edition of the *Handbook for Disaster Assessment*.

ECLAC

Economic Commission for Latin America and the Caribbean (ECLAC)
Comisión Económica para América Latina y el Caribe (CEPAL)
www.eclac.org