ENVIRONMENTAL IMPACT ASSESSMENT

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Introduction

Growing population → Growing demands → New projects → Pressure on natural resources → Altering the ecosystem functions

To control the alteration → Special attention should be paid to the starting point i.e. project → To bring → Implementing projects in a sustainable way → Sustainable development is responsive both to population demands as well as resources protection → Resulting in → A balance between the economical benefits and the damages of a project

Environmental Impact Assessment (EIA) is a decision-making tool aiming to achieve this balance

EIA is "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made (IAIA 1999)."

Aims and Objectives of EIA:

- **Aims:**
- Ensuring that environmental factors are explicitly addressed in decision-making processes concerning proposed development
- Improving the design of the proposed development
- Anticipating, avoiding, minimizing, and offsetting adverse effects related to development proposals on the human and biophysical environment
- Facilitating informed development decision-making

Aims and Objectives of EIA:

- **Objectives:**
- Protecting the productivity and capacity of human and natural systems and ecological functions
- Providing a means for public debate about the nature and direction of development
- Facilitation learning and environmental education
- Facilitating participatory approaches to development and decision-making
- Promoting development that is sustainable

Related terms:

- Effect/Impact/Change
- Assessment/evaluation
- Environment: physical/Biological/Socio-economic
- IA/EIA
-CEA
- ERA
- ESIA
- EIS/SEIS
-…
- EMP/EMS
-…
-…
- Sustainability Assessment
-…
-…
-CEA
-SEA

Definition of Strategic environmental assessment (SEA):
Fischer (2007)

is a systematic decision support process, aiming to ensure that environmental and possibly other sustainability aspects are considered effectively in policy, plan and programme making.

Sustainable development:

«Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. »

(World Commission on Environnent and Développement, 1987)

Sustainability Impact Assessment (SIA)

Definition of SIA:

(Arbter, 2003)

- ***systematic and iterative process***
- of the likely ***economic, social and environmental impacts***
- of ***policies, plans, programmes and strategies***
- enabling stakeholders concerned to ***participate pro-actively***

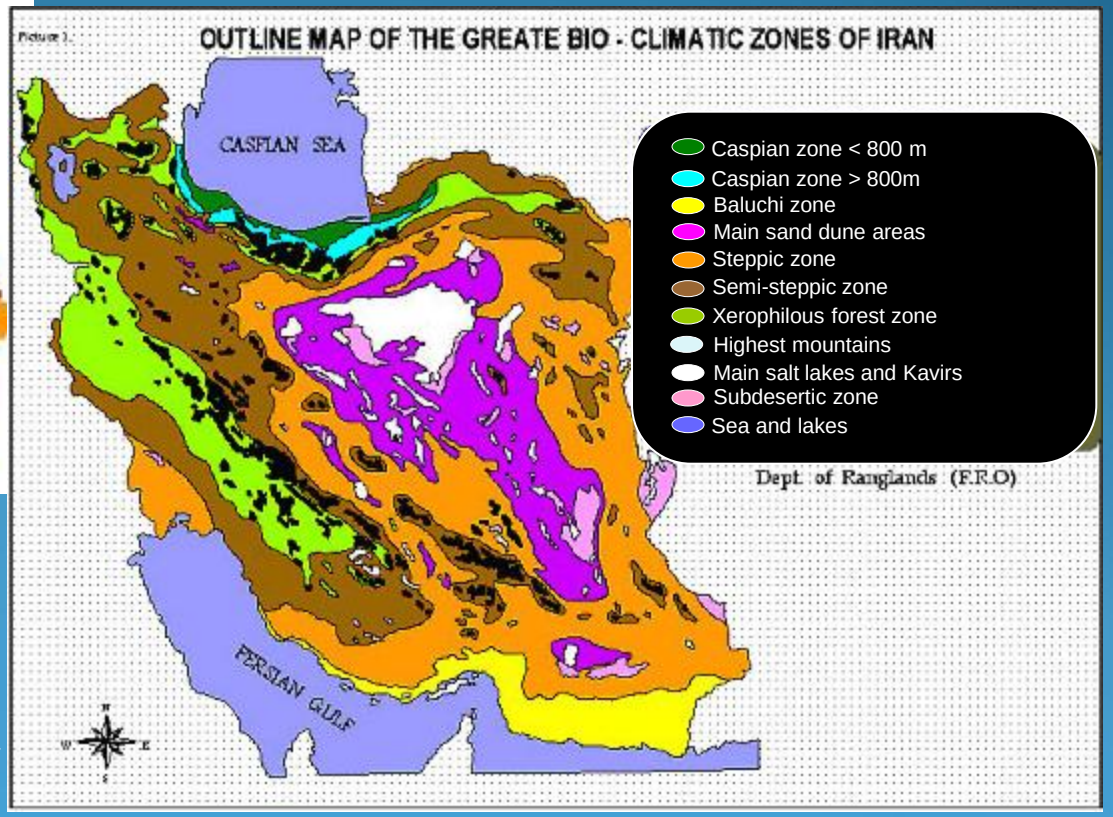
حیات انسان چقدر می ارزد؟

Why EIA is essential in Iran?

Introduction

Climatic and bio-climatic zones of Iran

Climatic zones



Bio-climatic zones

Overview of biodiversity in Iran

168 Mammals: 22 thereatened

8 Wild cat species

(Persian lion and Caspian tiger are extinct)

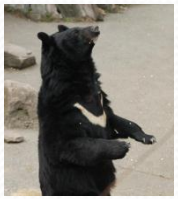
2 Bear species

3 Gazella species

3 Deer species

6 Sub-species of wild sheep













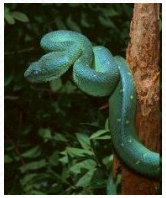
491 Bird species:

225 Breeding birds



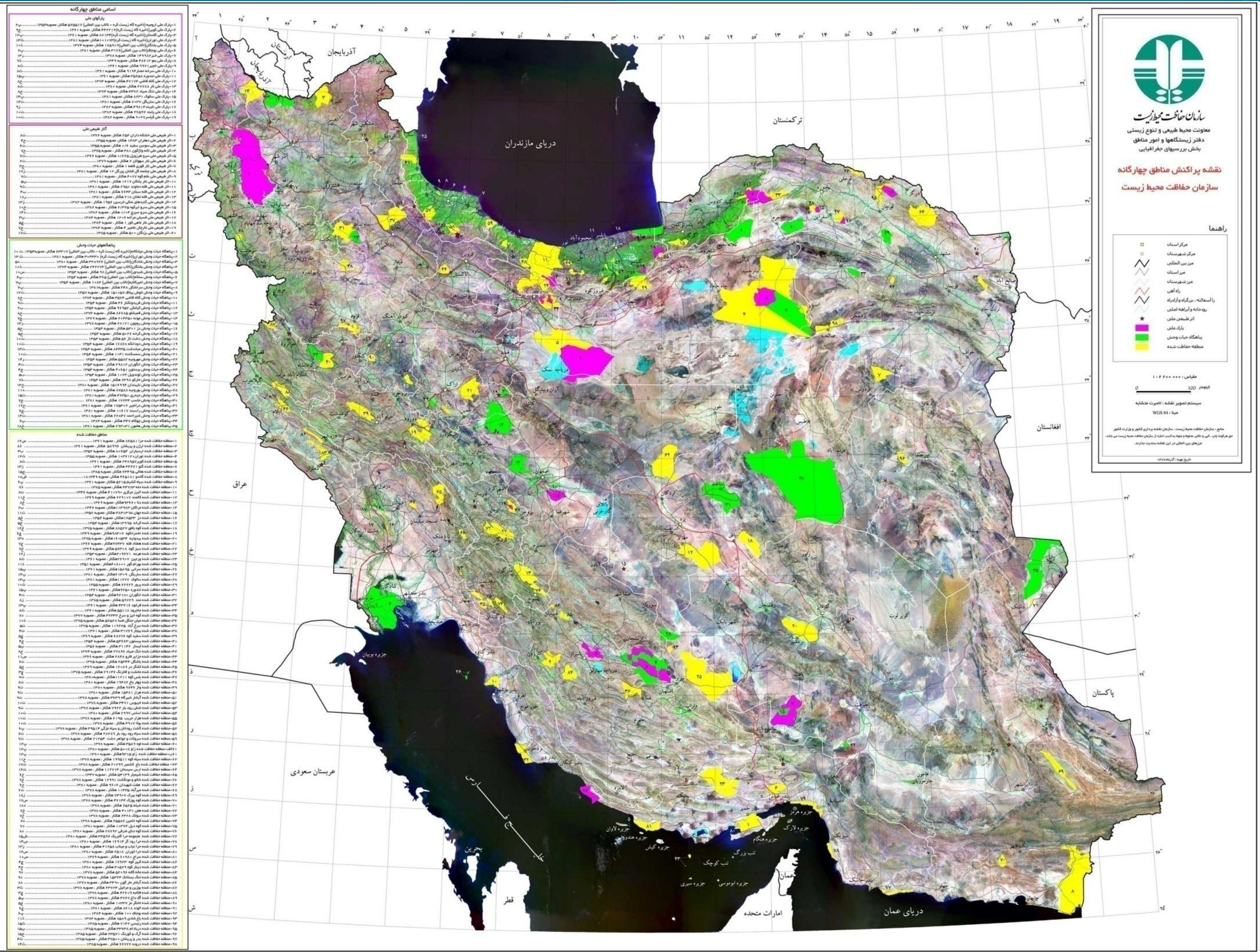



219 reptile species: 72 snake species,
23 amphibians



About 8,000 plant species: 1,800 endemic:
2,428 threatened: 24 species endangered




سازمان حفاظت محیط زیست
معاونت محیط طبیعی و تنوع زیستی
دفتر زیستگاهها و امور مناطق
بخش بررسیهای جغرافیایی
نقشه پراکنش مناطق چهارگانه
سازمان حفاظت محیط زیست
راهنما
مرکز استان
مرکز شهرستان
مرز بین المللی
مرز استان
مرز شهرستان
راه آهن
راه آسفالته ، بزرگراه و آزادراه
رودخانه و آبراهه اصلی
اثر طبیعی ملی
پارک ملی
پناهگاه حیات وحش
منطقه حفاظت شده
مقیاس : ۱:۲۲۰۰۰۰۰
کیلومتر 100 0
سیستم تصویر نقشه : لامبرت متشابه
مبنا : WGS 84
اسامی مناطق چهارگانه
پارکهای ملی
آثار طبیعی ملی
پناهگاههای حیات وحش
مناطق حفاظت شده
دریای مازندران
ترکمنستان
آذربایجان
افغانستان
پاکستان
عراق
عربستان سعودی
قطر
بحرین
امارات متحده
عمان
دریای عمان
خلیج فارس
کویر لوت
دریاچه نمک
جزیره کیش
جزیره لاوان
جزیره هرمز
جزیره لارک
جزیره قشم
تنب بزرگ
تنب کوچک
جزیره ابوموسی
جزیره سیری

Most frequent developmental projects in Iran











Introduction

Evolution of legislation

Law on waste disposal 2004

4th National Develomment Plan 2004

3rd National Develomment Plan 1998

EPHC Code of Practice on EIA 1994 DoE-EIA Bureau

2nd National Develomment Plan 1994

Earth Summit (Rio), 1992

Law on water Pollution control 1994

1st National Develomment Plan 1989

Law on Air Pollution control 1995

Article 50 - Constitution Of I.R.of IRAN 1980

Law for Protection of Protected and Sensitive Areas 1975

Protection Of seas and border rivers against oil pollution 1975

Law for Endangered Species of Wild Fauna and Flora 1974

Law for Endangered Species of Wild Fauna and Flora 1974

Law on Air pollution Cntrol 1974

Law on Environmental Protection 1974

1972 Department of the Environment

RAMSAR Convention 1971

Law on Hunting and Fishing 1965 Hunting and Fishing Control Organisation

Guidline on Hunting and FIshing 1957 Hunting Center

Institutional evolution

Stockholm Summit, 1972

قوانین و مقررات مرتبط با دفتر ارزیابی

- مصوبه شماره ۱۳۸ شورایعالی حفاظت محیط‌زیست درمورد ارزیابی اثرات محیط‌زیست ۱۳۷۳
- آیین‌نامه ارزیابی اثرات محیط‌زیستی مصوب شورایعالی حفاظت محیط‌زیست ۱۳۷۶
- ماده ۱۰۵ قانون برنامه سوم توسعه مصوب ۱۳۷۹
- ماده ۷۱ قانون برنامه چهارم توسعه مصوب ۱۳۸۴
- آیین‌نامه اجرایی ماده ۱۰۵ برنامه سوم توسعه تنفیذی در ماده ۷۱ برنامه چهارم توسعه مصوب ۱۳۸۷
- بند الف ماده ۱۹۲ قانون برنامه پنجم توسعه مصوب ۱۳۸۹
- تعیین نوع و مقیاس طرح‌ها و پروژه‌های مشمول انجام مطالعات ارزیابی محیط‌زیستی مصوب ۱۳۹۰ شورایعالی حفاظت محیط‌زیست
- ماده ۱۸۴ قانون برنامه پنجم توسعه در مورد ارزیابی راهبردی در سطوح ملی، منطقه ای و موضوعی
- ماده ۱۸۵ قانون برنامه پنجم توسعه در مورد نظام شاخص های پایداری
- ماده ۱۸۸ قانون برنامه پنجم توسعه در مورد ضوابط و معیارهای استقرار واحدهای صنعتی و تولیدی
- ماده ۱۹۰ برنامه پنجم توسعه در مورد مدیریت سبز

سیاستهای کلی دفتر ارزیابی اثرات:

۱. ارزیابی اثرات زیست محیطی راهبردی برنامه های توسعه همگام با ارزیابی اثرات زیست محیطی تجمعی و پروژه ای
۲. تدوین و بازنگری قوانین، مقررات، استانداردها و دستورالعمل‌های زیست‌محیطی در سطوح کشوری و منطقه‌ای
۳. شناسایی تهدیدها و مخاطرات زیست‌محیطی کشور در حوزه محیط‌زیست انسانی و برنامه‌ریزی زمان محور جهت تبدیل آنها به فرصت به منظور ارتقاء کیفیت محیط‌زیست و سلامت مردم.
۴. ایجاد پایگاه اطلاعاتی نظام ارزیابی محیط زیست کشور
۵. اطلاع رسانی، تنویر افکار عمومی و فرهنگ سازی زیست محیطی و ایجاد جریان آزاد اطلاعاتی
۶.تهیه و تدوین اقلام اطلاعاتی پایه

Screening: Is an EIA required?

World Bank Screening List

Box 5.2 World Bank Project Screening Lists

Category A Projects

These projects are likely to have significant adverse environmental impacts that are diverse, are unprecedented, or affect an area beyond the specific project site. A full EIA is required for such projects as:

- large-scale industrial plants
- dams and reservoirs
- port and harbour development
- large-scale irrigation
- river basin development
- hazardous or toxic materials involvement
- reclamation and new land development
- forestry and production projects
- large-scale land clearance
- oil, gas, and mineral development
- large-scale drainage or flood control
- thermal or hydropower development
- manufacture, transport, use of pesticides
- resettlement

Category B Projects

These projects are likely to have adverse impacts but are less significant than Category A projects. Most impacts are reversible, manageable, and site-specific. Projects include:

- electricity transmission
- renewable energy development
- tourism development
- small-scale irrigation and drainage
- rural water supply or sanitation
- watershed management or rehabilitation
- agro-industries
- rural electrification
- small-scale aquaculture
- rural electricity supply
- small project maintenance or upgrading

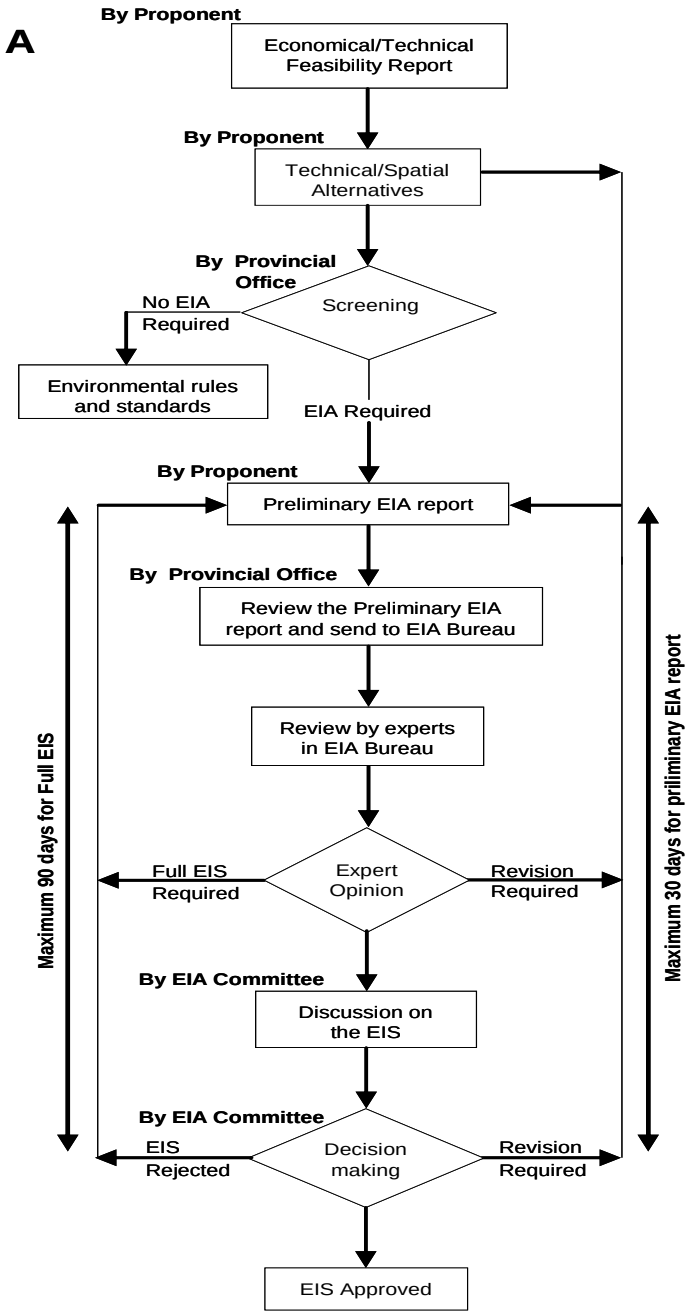
Category C Projects

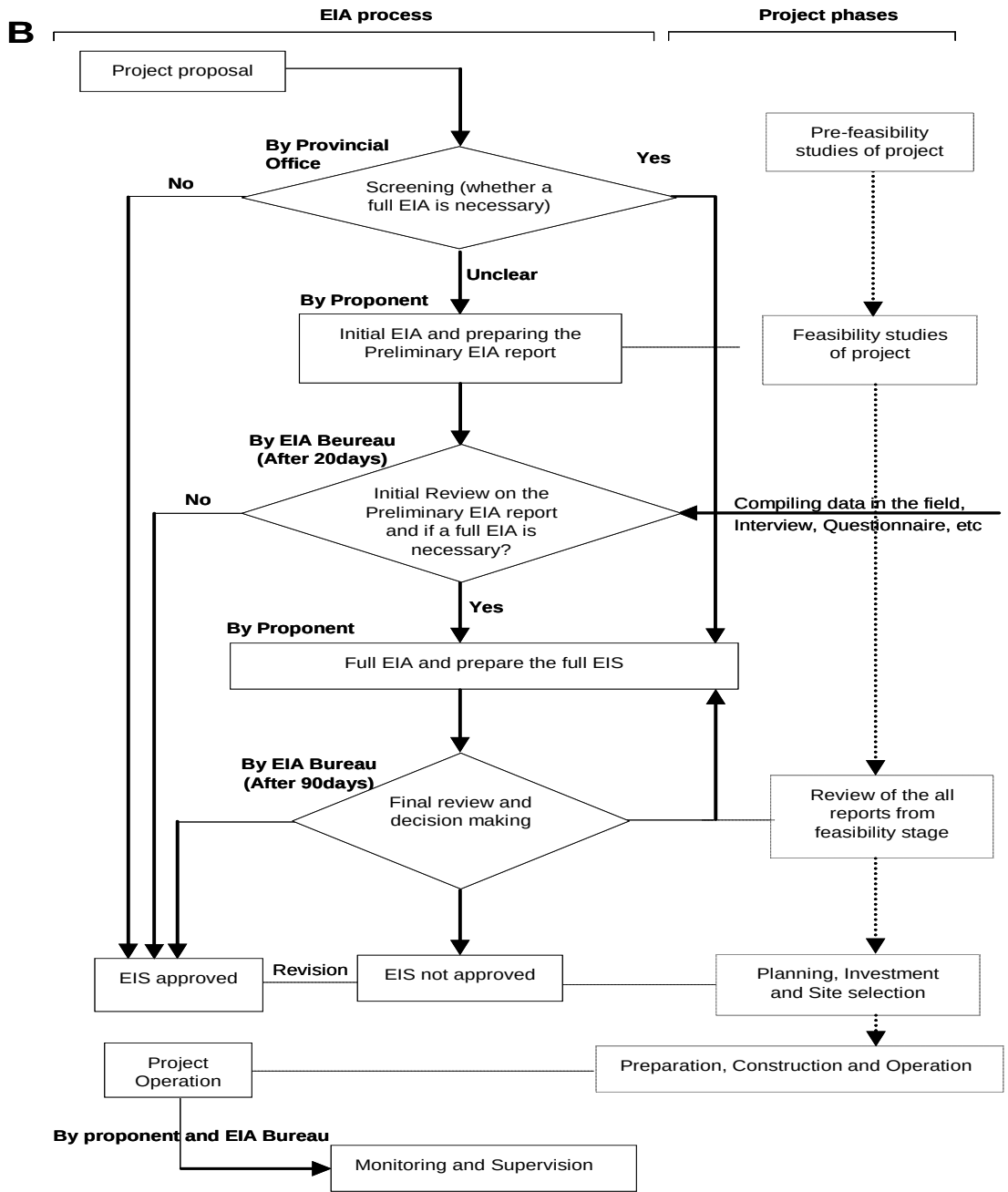
These projects are likely to generate only minimal or no significant adverse environmental impacts. No EIA is required for projects concerning:

- education initiatives
- nutrition programming
- institution development
- most human resource projects
- family planning
- health initiatives
- technical assistance

Source: World Bank 1993.

EIA process in Iran


A
By Proponent
Economical/Technical Feasibility Report
By Proponent
Technical/Spatial Alternatives
By Provincial Office
Screening
No EIA Required
Environmental rules and standards
EIA Required
By Proponent
Preliminary EIA report
By Provincial Office
Review the Preliminary EIA report and send to EIA Bureau
Review by experts in EIA Bureau
Expert Opinion
Full EIS Required
Revision Required
By EIA Committee
Discussion on the EIS
By EIA Committee
Decision making
EIS Rejected
Revision Required
EIS Approved
Maximum 90 days for Full EIS
Maximum 30 days for priliminary EIA report


B
EIA process
Project phases
Project proposal
By Provincial Office
Screening (whether a full EIA is necessary)
No
Yes
Unclear
Pre-feasibility studies of project
By Proponent
Initial EIA and preparing the Preliminary EIA report
Feasibility studies of project
By EIA Beureau (After 20days)
Initial Review on the Preliminary EIA report and if a full EIA is necessary?
No
Compiling data in the field, Interview, Questionnaire, etc
Yes
By Proponent
Full EIA and prepare the full EIS
By EIA Bureau (After 90days)
Final review and decision making
Review of the all reports from feasibility stage
EIS approved
Revision
EIS not approved
Planning, Investment and Site selection
Project Operation
Preparation, Construction and Operation
By proponent and EIA Bureau
Monitoring and Supervision

Screening List in Iran

جدول ۲-۵- طرحها و پروژه‌های مشمول انجام مطالعات ارزیابی زیست محیطی

ردیف	عنوان طرح	عنوان پروژه / نوع منطقه	منطقه خزری (استانهای شمالی کشور)	نوار ساحلی جنوب (کلیه شهرستانهای نوار ساحلی جنوب)	عرصه‌های جنگلی (پهن برگ سوزنی برگ حفاظتی، مانگروز، اگرسی پارکهای جنگلی طبیعی و دست کاشت)	حریم مناطق تحت حفاظت سازمان و تالاب های بین المللی	حوضه های آبریز بلافصل سدها و سایر تالاب ها	آبخوانها و سفره های آب شرب	دریاها و دریاچه ها و جزایر	مناطق کوهستانی (شمالغرب، غرب و جنوبغرب کشور)	سایر مناطق (بیابانی و دشت های حوضه مرکزی، جنوبی و شرقی)	ملاحظات
۱	راه و راه آهن	آزادراه	در هر مقیاس بدون در نظر گرفتن منطقه بندی									
۲		بزرگراه (در هر مقیاس)	√	تا ۲۰ کیلومتری عرض ساحلی	√	√	مقاطع رودخانه‌های اصلی، خورها و تالاب ها	-	√	-	-	
۳		جاده اصلی درجه یک (در هر مقیاس)	√	-	√	√	مقاطع رودخانه‌های اصلی، خورها و تالاب ها	-	√	-	-	
۴		راه آهن (در هر مقیاس)	√	تا ۲۰ کیلومتری عرض ساحلی	√	√	مقاطع رودخانه‌های اصلی، خورها و تالاب ها	-	√	-	-	به استثناء مسیرهای دسترسی اختصاصی
۵	نیروگاه	گازی (در هر مقیاس)	√	√	√	√	√	√	√	√	√	به استثنای نیروگاههای مولد مقیاس کوچک

Box 1.5 Generic EIA Process

Project description	Description of the proposed action, including its alternatives, and details sufficient for an assessment.
Screening	Determination of whether the action is subject to an EIA under the regulations or guidelines present, and if so what type or level of assessment is required.
Scoping	Delineation of the key issues and the boundaries to be considered in the assessment, including the baseline conditions and scoping of alternatives.
Impact prediction and evaluation	Prediction of environmental impacts and determination of impact significance.
Impact management	Identification of impact management and mitigation strategies and development of environmental management or protection plans.
Review and decision	Technical and public review of EIS and related documents and subsequent recommendation as to whether the proposed action should proceed and under what conditions.
Implementation and follow-up	Implementation of project and associated management measures; continuous data collection to monitor compliance with conditions and regulations; monitoring the effectiveness of impact management measures and the accuracy of impact predictions.

Public consultation

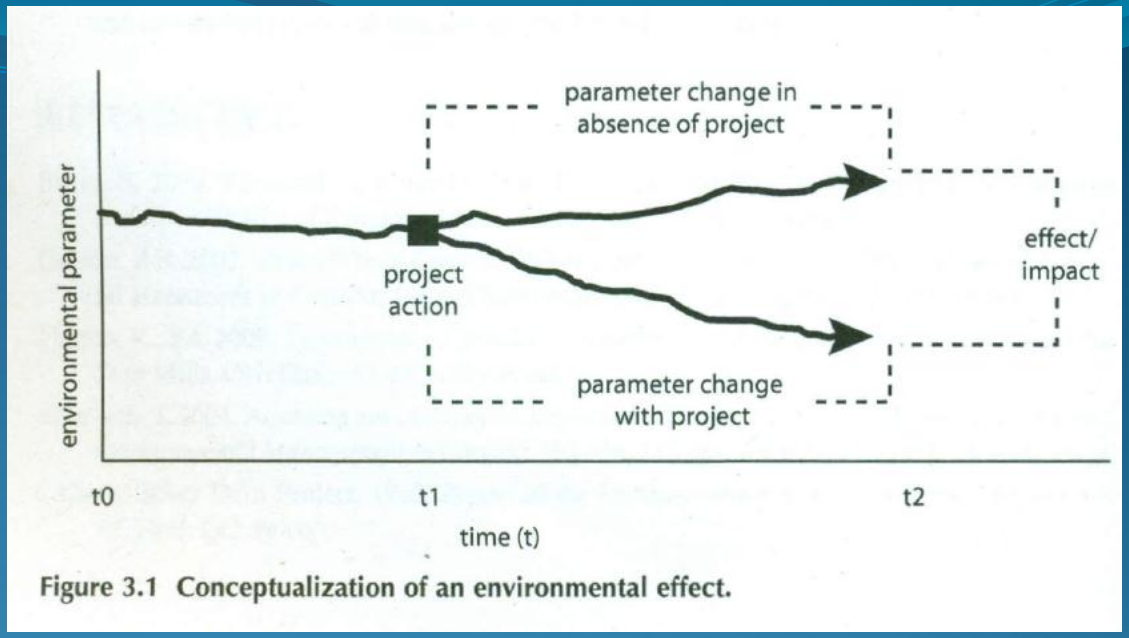


Figure 3.1 Conceptualization of an environmental effect.

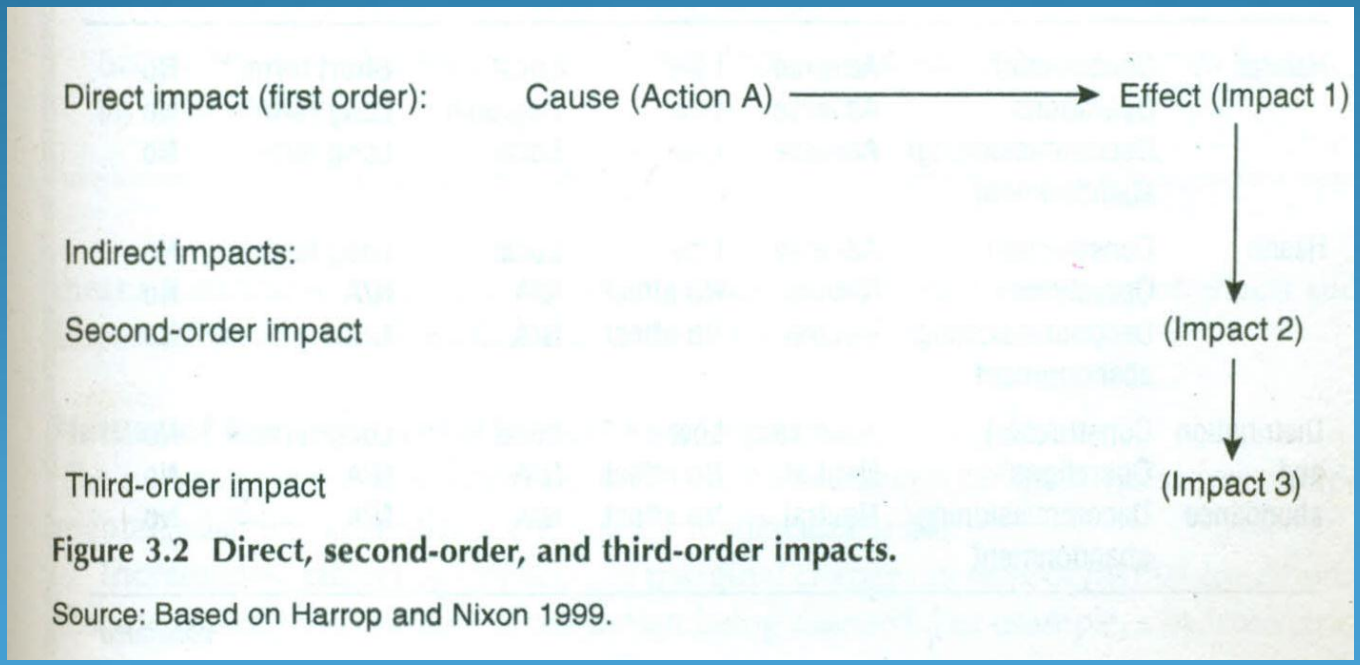
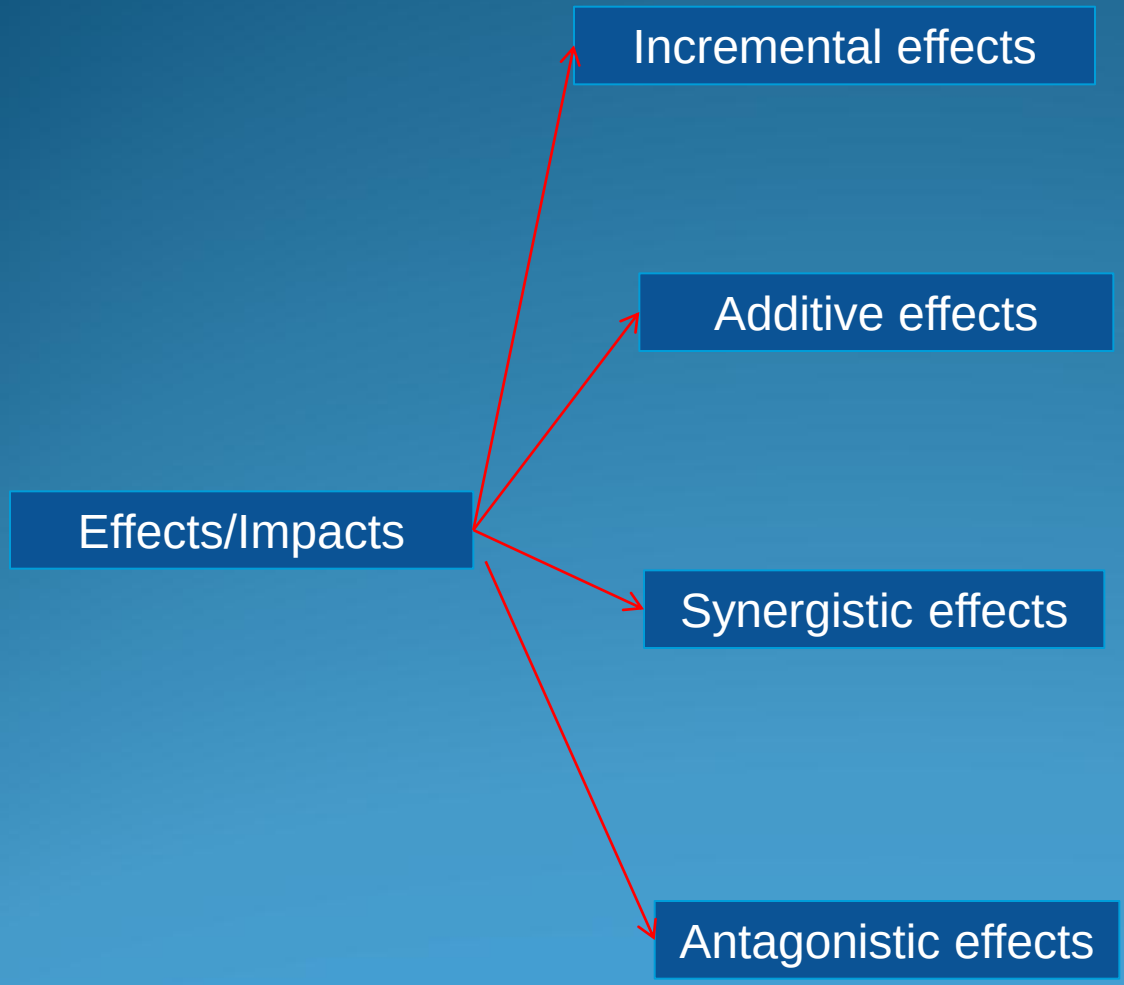


Figure 3.2 Direct, second-order, and third-order impacts.

Source: Based on Harrop and Nixon 1999.

Nature of environmental impacts

Rate of increases in heavy metal concentration, and standards



A: 10% mortality
B: 10% mortality

Effects of heavy metals on fish in higher temperature and lower dissolved oxygen

What attributes?

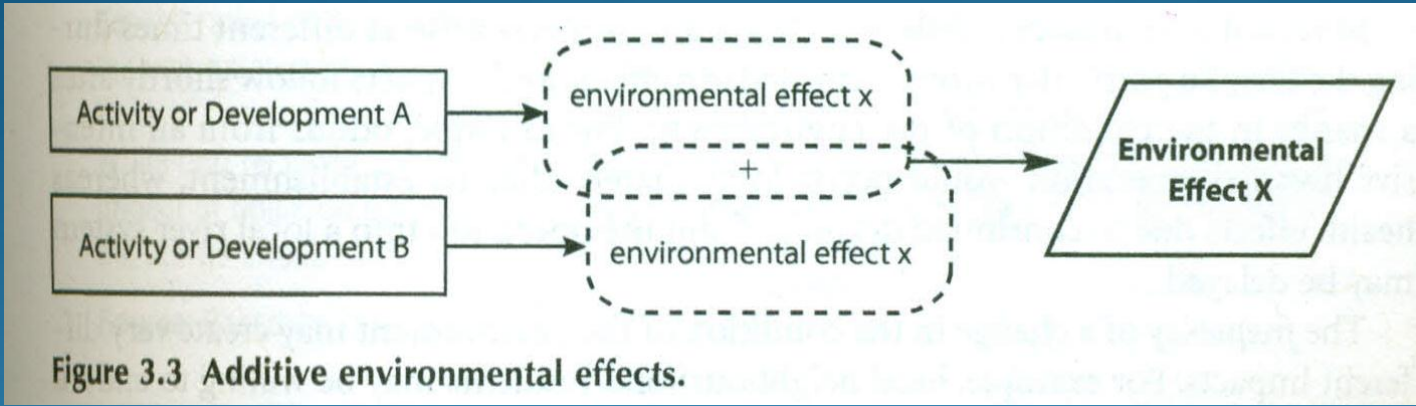


Figure 3.3 Additive environmental effects.

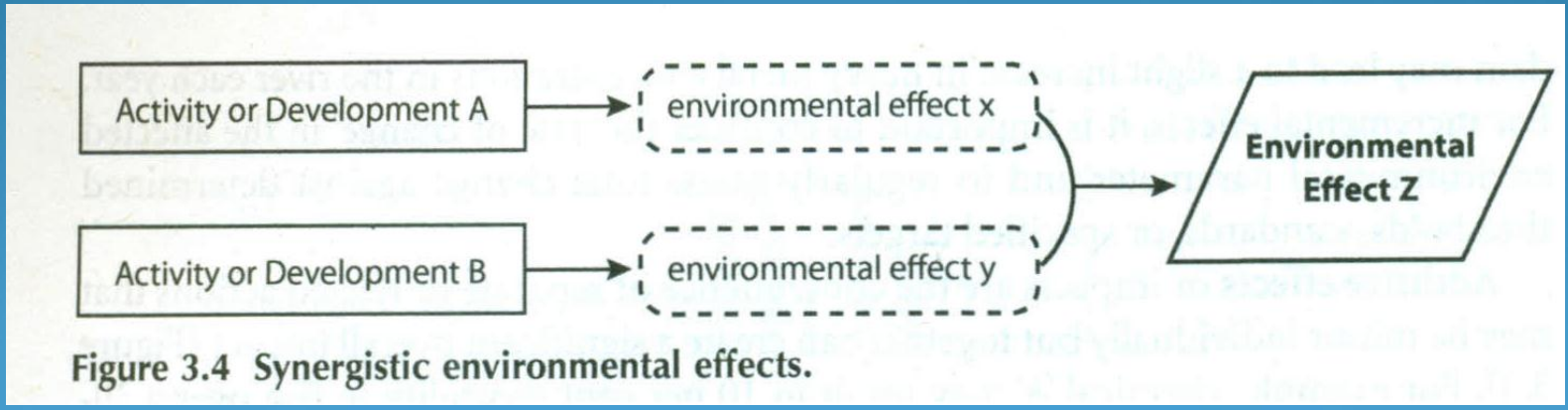


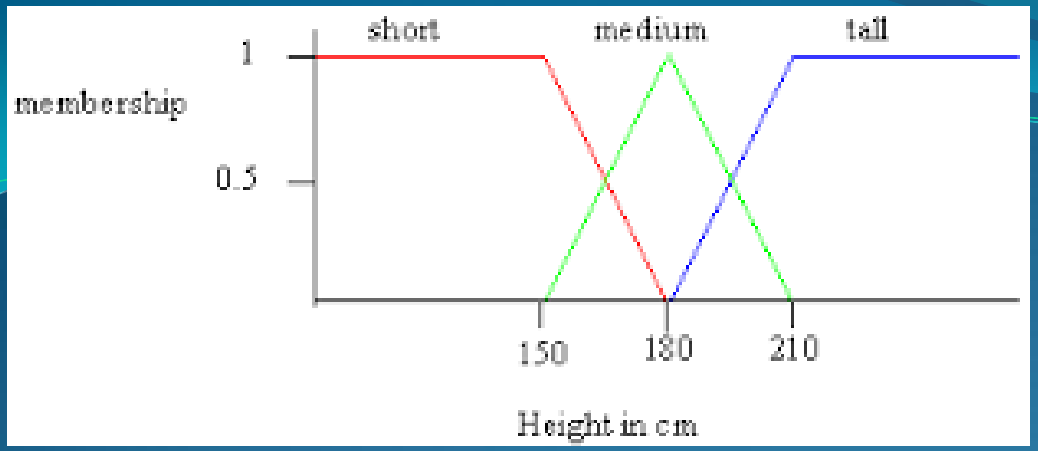
Figure 3.4 Synergistic environmental effects.

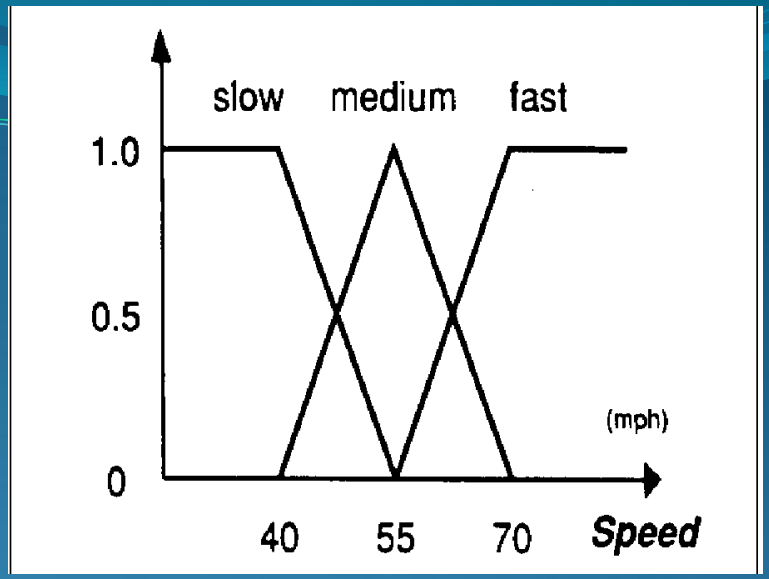
Temporal characteristics of environmental impacts

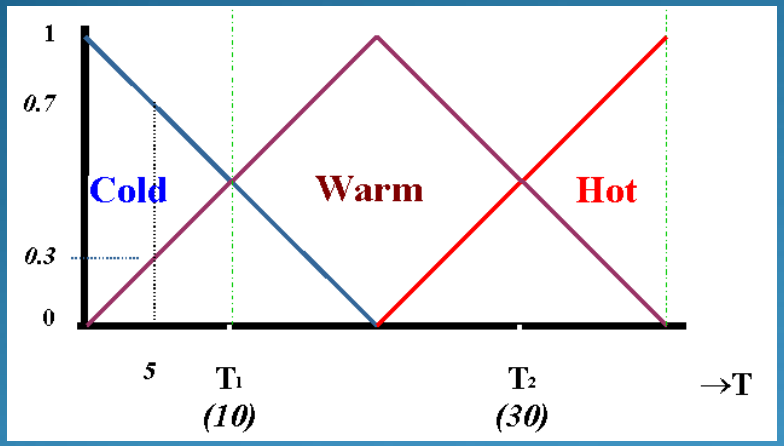
- **Duration……Length of time that impact occurs**
- **Continuity……continues/ discontinues, electricity, noise from blasting**
- **Immediacy……odor/health effects from livestock operation**
- **Frequency ……street and airport noise**
- **Regularity……..military operation**

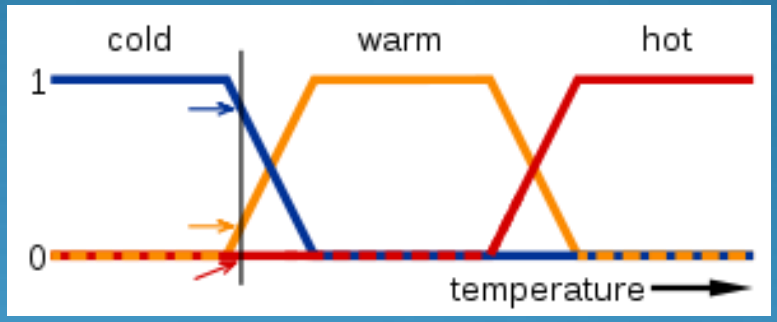
Other effects attributes

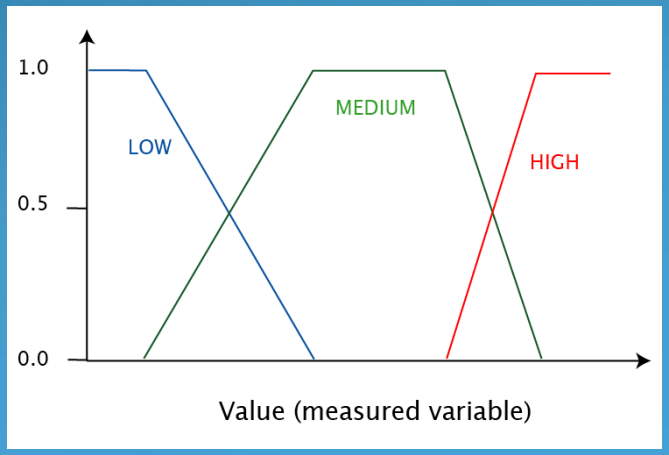
- **Magnitude**
- **Direction (adverse-Neutral-Positive)**
- **Spatial extent**
- **Reversibility/irreversibility**
- **Likelihood**

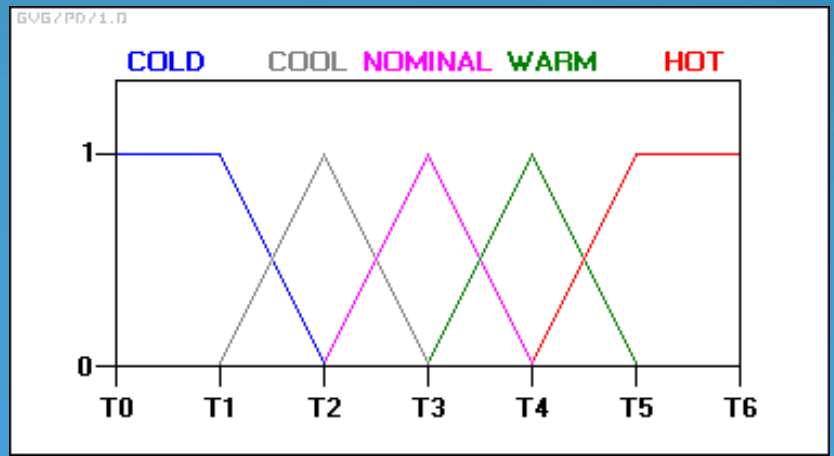

short
medium
tall
membership
1
0.5
150
180
210
Height in cm


slow
medium
fast
1.0
0.5
0
(mph)
40
55
70
Speed

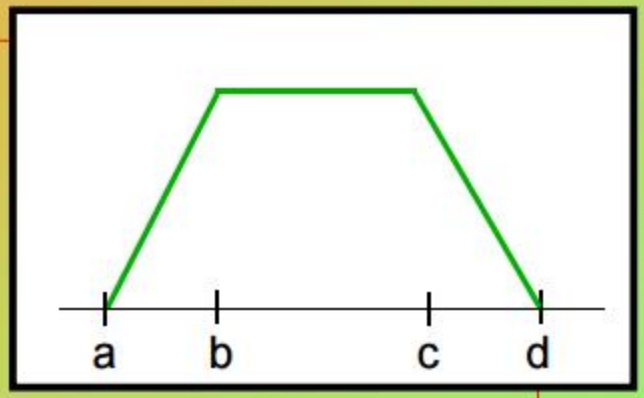

1
0.7
0.3
0
Cold
Warm
Hot
5
T1
(10)
T2
(30)
→T


cold
warm
hot
1
0
temperature


1.0
0.5
0.0
LOW
MEDIUM
HIGH
Value (measured variable)


COLD
COOL
NOMINAL
WARM
HOT
1
0
T0
T1
T2
T3
T4
T5
T6

Trapezoidal Membership Functions



Regular Trapezoid

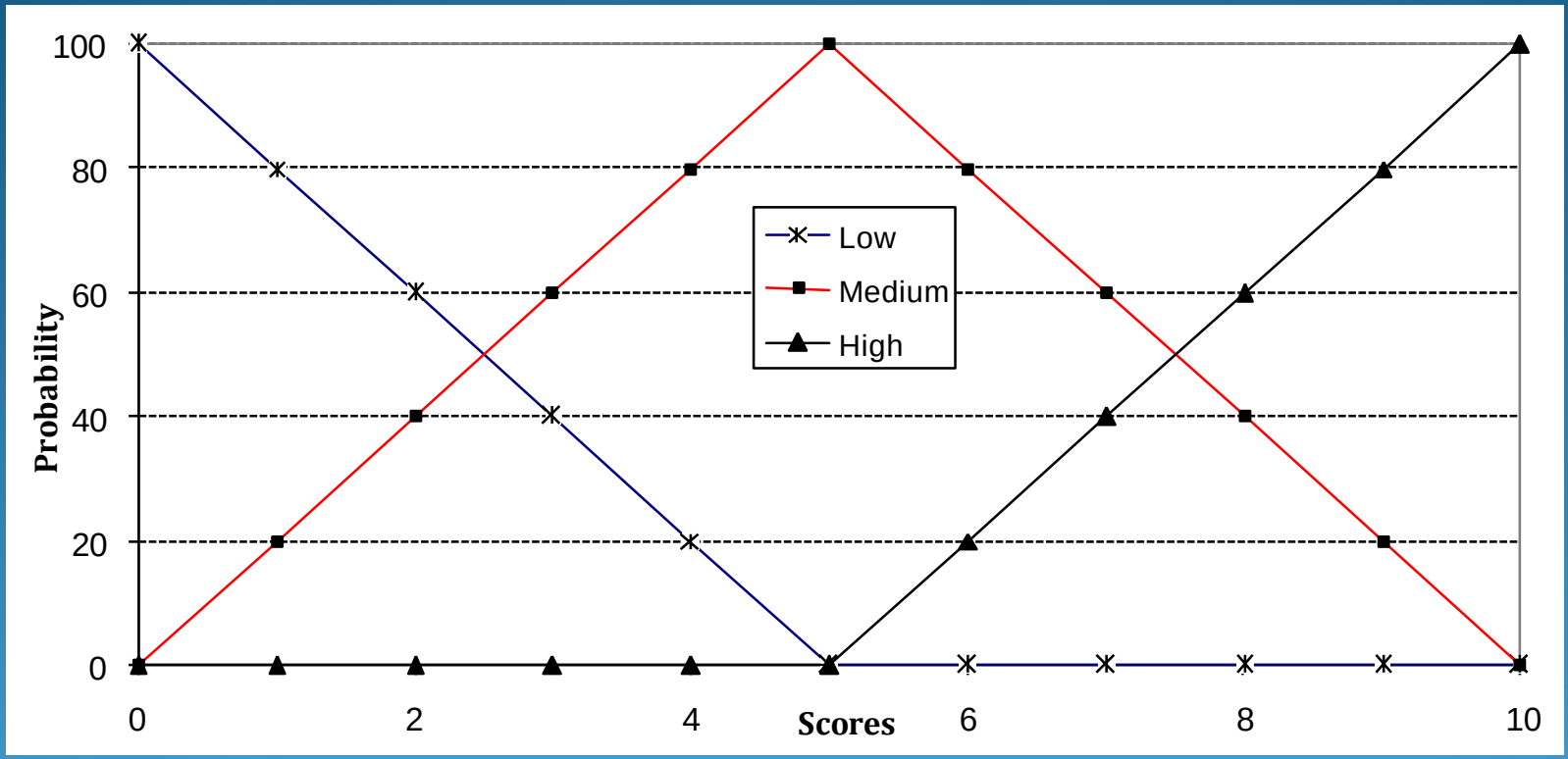
Left_Slope = 1 / (B - A)
Right_Slope = 1 / (C - D)

CASE 1: X <= a Or X >= d
Membership Value = 0

CASE 2: X >= b And X <= c
Membership Value = 1

CASE 3: X >= a And X <= b
Membership Value = Left_Slope * (X - a)

CASE 4: (X >= c) And (X <= d)
Membership Value = Right_Slope * (X - d)


100
80
60
40
20
0
Probability
0
2
4
Scores
6
8
10
Low
Medium
High

Q

Low:
$$\begin{cases} \dfrac{x-0}{y-100} = \dfrac{5}{-100} & 0 \le x \le 5 \\ 0 & x > 5 \end{cases}$$

Medium
$$\begin{cases} \dfrac{x-0}{y-0} = \dfrac{5}{100} & 0 \le x \le 5 \\ \dfrac{x-5}{y-100} = \dfrac{-5}{100} & 5 \le x \le 10 \end{cases}$$

High
$$\begin{cases} 0 & x < 5 \\ \dfrac{x-5}{y-100} = \dfrac{5}{100} & x > 5 \end{cases}$$

Scoping:

- Determines of the important issue and parameters that should be addressed in an EIA,
- establishes spatial and temporal boundaries,
- focuses on the relevant issues and concerns.

Table 6.3 Scoping the Biophysical Environment

Air
- current pollutant concentration
- pollutant dispersion
- emission levels
- emission types
- temperatures
- windspeeds and directions

Soil
- erosion rates
- moisture content
- fertility
- organic matter
- electrical conductivity
- chemical composition
- stability
- soil pollutants

Terrestrial
- level of fragmentation
- widlife populations
- vegetation cover and composition
- air- and water-borne pollutants
- levels of light pollution
- vegetation health

Water
- surface quantity
- surface water withdrawal
- groundwater quantity
- groundwater withdrawal
- chemical content
- turbidity
- stream flow
- bank stability
- levels of eutrophication
- current pollution discharges
- fish and fish habitat

Coastal zone
- water temperature
- flood frequency
- tidal activity
- sedimentation
- marine resource populations
- bank or cliff stability

Scoping the Human Environment

Table 6.4 Scoping the Human Environment

Economics
- local and non-local employment
- labour supply
- wage levels
- skill and education level
- retail expenditures
- material and service suppliers
- regional multiplier
- tourism

Demographics
- population
- population characteristics (family size, income, ethnicity)
- settlement patterns

Health
- quality of life (actual and perceived)
- medical standards
- worker death or injury rates
- current disease transmission
- mental and physical well-being

Housing
- public and private housing
- house prices
- homelessness and housing problems
- density and crowding

Local services
- educational services
- health services
- community services (police, fire)
- transportation services and infrastructure
- financial services

Socio-cultural
- family life
- seasonality of employment
- culture and belief systems
- crime rates, substance abuse, divorce rates
- community conflict and cohesion
- traditional foodstuffs
- community perception
- gender relations

How to establish a Spatial Boundaries:

Box 6.4 Principles for Spatial Bounding

- Boundaries must be large enough to include relationships between the proposed project, other existing projects and activities, and the affected environmental components (Cooper 2003).
- The scope of assessment should cross jurisdictions if necessary and allow for interconnections across systems (Shoemaker 1994).
- Natural boundaries should be respected (Beanlands and Duinker 1983).
- Different receptors will require assessment at different scales (Shoemaker 1994).
- Boundaries should be set at the point where effects become insignificant by establishing a maximum detectable zone of influence (Scace, Grifone, and Usher 2002).
- Both local and regional boundaries should be established (Canter 1999).

Geographic boundaries for any particular assessment will vary depending on a number of factors, including the nature of the project itself, sensitivity of the receiving environment, nature of the impacts, extent of transboundary impacts, availability of baseline data, jurisdictional boundaries and cooperation, and natural physical boundaries.

How to establish a Spatial Boundaries:

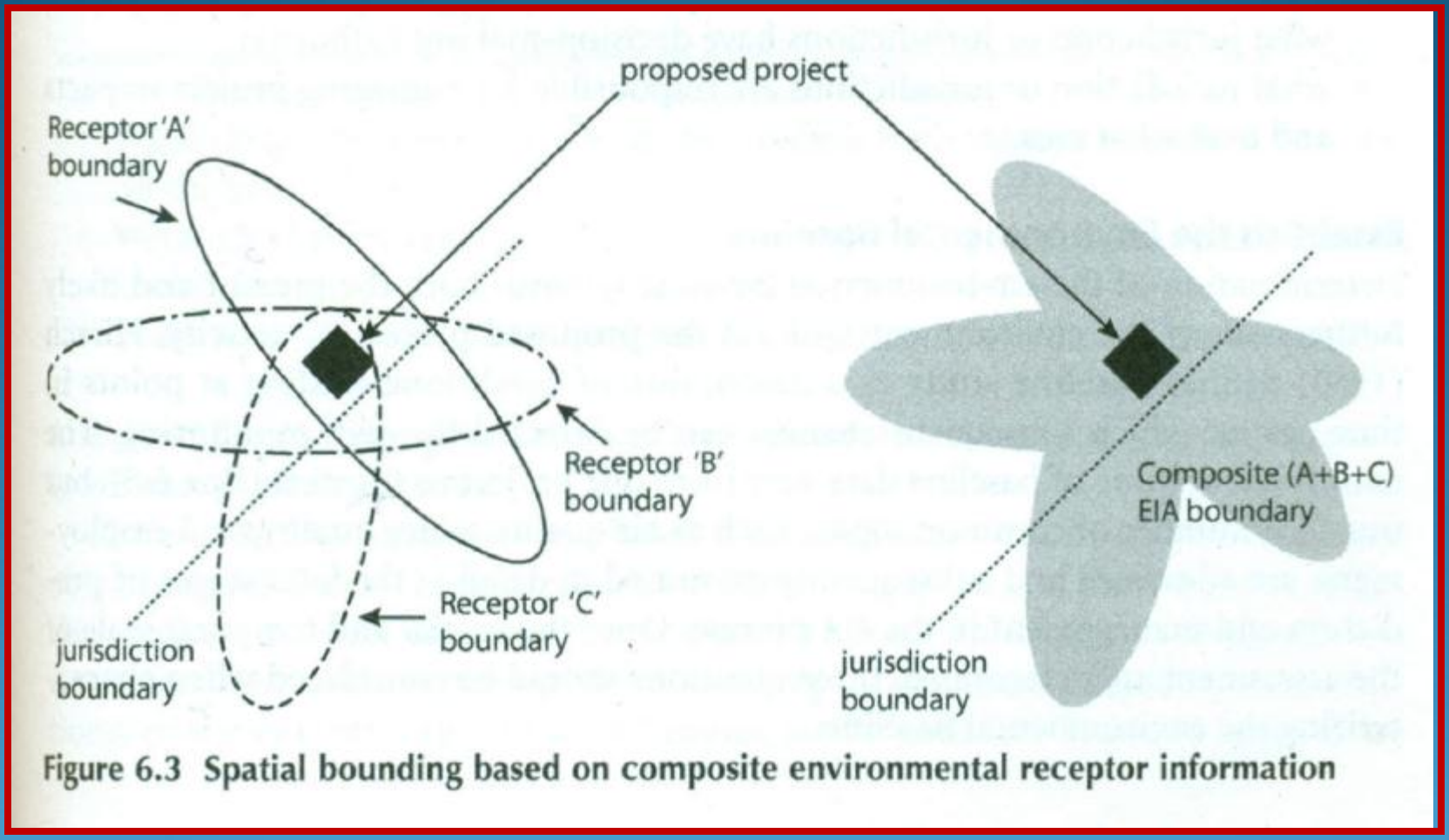
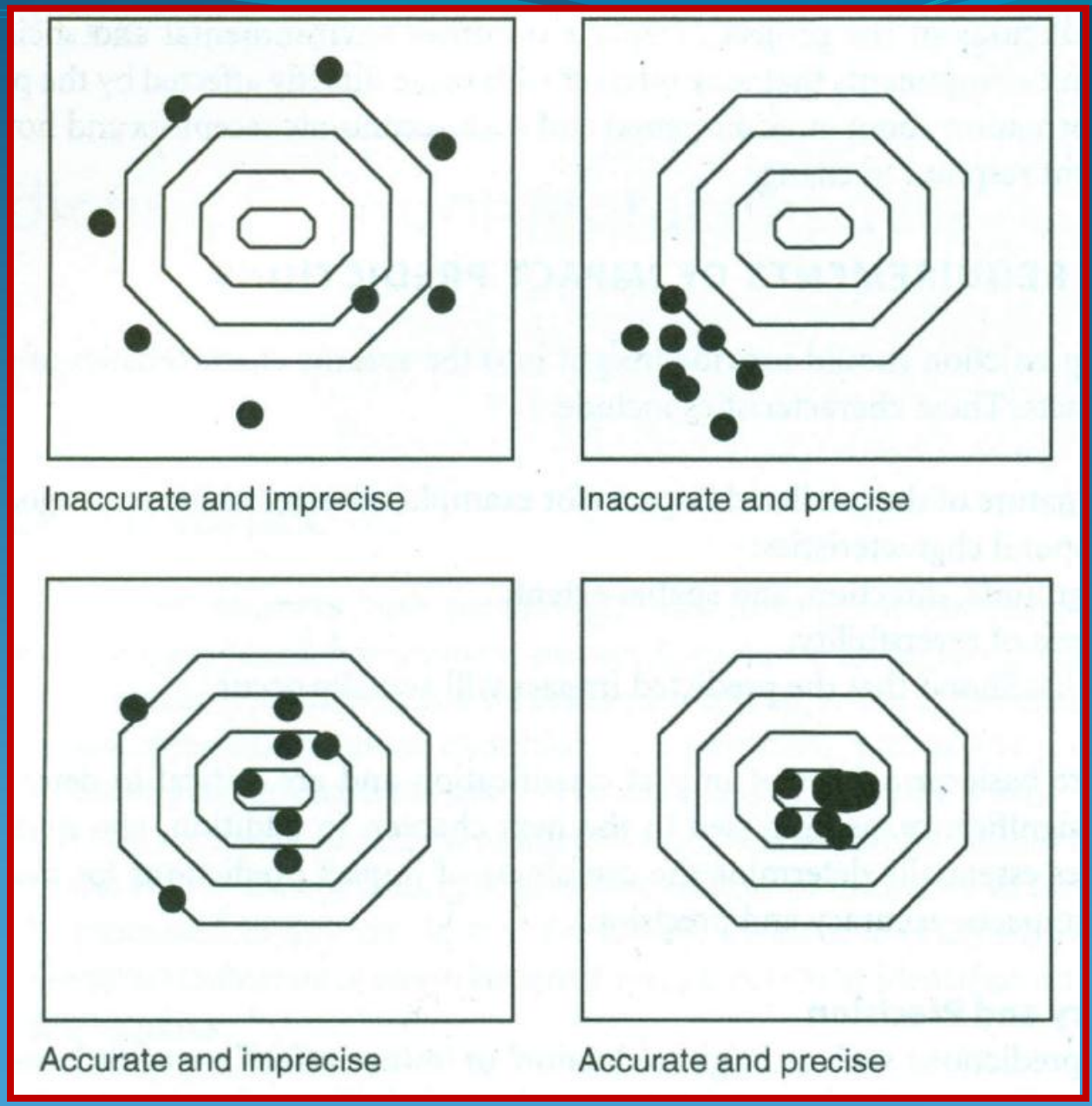


Figure 6.3 Spatial bounding based on composite environmental receptor information

Impact prediction

Accuracy vs Precision



Impact prediction

What to predict?

Table 7.1 Selected Biophysical Environmental Impacts: Examples of What to Predict

Air quality impacts
- pollutant concentration (various)
- pollutant dispersion
- emission levels
- emission types
- temperature
- changes in wind speed

Soil quality impacts
- erosion
- moisture
- fertility (nutrient change)
- changes in organic matter
- electrical conductivity
- chemical change
- stability
- soil pollution

Terrestrial impacts
- fragmentation
- wildlife populations
- vegetation cover and composition
- air- and water-borne pollutants
- light pollution
- disturbance
- vegetative trampling

Water impacts
- surface quantity
- surface water withdrawal
- groundwater quantity
- groundwater withdrawal
- chemical change
- turbidity
- streamflow change
- bank erosion (flood risk)
- biological change (eutrophication, algal blooms)
- pollution discharge rates (assimilative capacity)
- biological resources (fish and fish habitat)

Coastal zone impacts
- water temperature
- flooding
- alterations to tidal activity
- sedimentation
- marine resource populations
- bank or cliff stability

Impact prediction

How to predict?

Table 7.2 Sample Techniques Used for Prediction in the Biophysical Environment

Air	• dispersion modelling • box models • air quality indices • monitoring from analogues
Biological	• species population models • habitat simulation modelling • ecological risk assessment • biological assessments
Surface water	• waste load allocations • statistical models • hydrological models • water usage and allocation studies
Groundwater	• pollution source surveys • mixing models • flow and transport models • soil and groundwater vulnerability indices

Impact prediction

What to predict?

Table 7.3 Selected Human Environmental Impacts: Examples of What Predict

Direct economic impacts
- local and non-local employment
- labour supply and training
- wage levels
- employment demand by skill group

Indirect economic impacts
- retail expenditures
- material and service suppliers
- labour market pressures
- regional multiplier effects
- tourism

Demographic impacts
- changes in population size
- changes in population characteristics (family size, income, ethnicity)
- changes in settlement patterns

Health impacts
- quality of life (actual and perceived)
- medical standards
- worker safety (risk of death or injury)
- disease introduction and transmission
- physiological impacts (stress, worker satisfaction)
- mental and physical well-being

Housing impacts
- housing demand
- public and private housing
- house prices
- homelessness and housing problem
- density and crowding

Local service impacts
- educational services
- health services
- community services (police, fire)
- transportation services and infrastr
- financial services

Socio-cultural impacts
- lifestyle changes (family life, seasor of employment)
- threats to culture and belief system
- perceived and actual risks
- social problems (crime rates, subst abuse, divorce
- community stress (conflict, integra cohesion)
- traditional foodstuffs
- local pride and community percepti
- aesthetic impacts
- gender relations

Impact prediction

How to predict?

Table 7.4 Sample Techniques Used for Prediction in the Human Environment

Social	• demographic models • participatory mapping • health-based risk assessment • intention surveys
Economic	• economic multipliers • total economic productivity models • input-output analysis • Monte Carlo analysis
Cultural	• traditional knowledge • participatory mapping • community dialogues • analogue techniques

Example: effects of Gas-gathering piplines and facilities on fish and fish habitat for the Mackenzie Gas Project

Box 3.2 Effects of Natural Gas–Gathering Pipelines and Facilities on Fish and Fish Habitat for the Mackenzie Gas Project, Northwest Territories

		Effect attribute				
Key indicators	*Phase when impact occurs*	*Direction*	*Magnitude*	*Geographic extent*	*Duration*	*Significant*
Habitat	Construction	Adverse	Low	Local	Short term	No
	Operations	Adverse	Low	Regional	Long term	No
	Decommissioning/ abandonment	Adverse	Low	Local	Long term	No
Health	Construction	Adverse	Low	Local	Long term	No
	Operations	Neutral	No effect	N/A	N/A	No
	Decommissioning/ abandonment	Neutral	No effect	N/A	N/A	No
Distribution and abundance	Construction	Adverse	Low	Local	Long term	No
	Operations	Neutral	No effect	N/A	N/A	No
	Decommissioning/ abandonment	Neutral	No effect	N/A	N/A	No

Effect attributes:

Direction

Adverse: Impact will cause an adverse change in a measurable parameter relative to baseline conditions or trends.

Neutral: Impact will cause no change in a measurable parameter relative to baseline conditions or trends.

Positive: Impact will cause a positive change in a measurable parameter relative to baseline conditions or trends.

Magnitude

No effect: No change in the valued component.

Low: An individual or group within a population found in a localized area, such as the local or regional study area, might be affected.

Moderate: Part of a regional population within the local or regional study area might be affected, changing the abundance or distribution of the valued component and affecting opportunities for hunting, trapping, or viewing wildlife as currently practised.

High: An entire population within the local or regional study area might be affected, changing the abundance or distribution to such an extent that the population would not likely return to its previous level, resulting in reduced population viability and unsustainable harvest compared with current practice.

Geographic extent

Local: Terrestrial—the effect on the valued component is measurable within the local study area; marine—the effect will be limited to within about 10 kilometres of the proposed activity.

Regional: Terrestrial—the effect on the valued component is measurable within the regional study area; marine—the effect will extend beyond 10 kilometres of the proposed activity to the Canadian Beaufort Sea region.

Beyond regional: Terrestrial—the effect on the valued component is measurable beyond the regional study area.

Duration

Short term: Effect is limited to less than one year.

Medium term: Effect lasts for more than one year but less than four years.

Long term: Effect lasts longer than four years, but the valued component will recover not more than 30 years after project decommissioning.

Far future: Effect extends more than 30 years after decommissioning.

Source: Mackenzie Gas Project Environmental Impact Statement, 2004, v. 5, section 7, pp. 7-183 to 10-27.

Impact evaluation and determination of significance

Box 4.1 Partial Checklist for a Bridge Construction Project

Proposed project activities:	
dredging	☑
blasting	☐
pier construction	☑
traffic diversion	☑
Affected physical components:	
water quantity	☐
water quality	☑
soil quality	☐
soil stability	☑
air quality	☐
Affected biological components	
fish populations	☑
spawning habitat	☑
cavity nesting bird habitat	☐
wildlife habitat	☐
rare or endangered species	☐
Affected socio-economic components	
employment	☑
noise	☑
health	☐

Box 4.2 Types of Simple EIA Checklists

Descriptive checklists: Provide guidance on how to assess certain impacts, including data requirements and potential information sources.

Data requirements	*Data or information source and techniques*
Water quality:	
water uses, baseline chemicals present, runoff data	water user surveys, water quality analysis, hydrological modelling
Employment impacts:	
economic base, workforce characteristics, job creation	industry survey, community profiling, regional multipliers

Questionnaire checklists: Propose a set of questions that must be answered when considering the potential effects of a proposed development.

	Yes	No	?
Will the project cause pollution of air, water, or soil?			
Will there be a discharge of solid or dissolved substances to waste water?	☐	☐	☐
Is there a risk of discharge of gases that are damaging to health or environment?	☐	☐	☐
Is there risk of a potential impact on drinking water?	☐	☐	☐
Will the activity cause discharge of dust to the atmosphere?	☐	☐	☐
Will the project cause waste problems?	Yes	No	?
Will waste be created during operations that is hazardous to human health?	☐	☐	☐
Is there a risk that tailings may contaminate local water and soil resources?	☐	☐	☐
Have the long-term environmental impacts of mine waste been considered?	☐	☐	☐
Is the proposed management of hazardous waste in compliance with standards?	☐	☐	☐

Source: Based on NORAD 1994.

Threshold of concern checklists: List environmental components that might be affected by the project actions, specific criteria for each component, and thresholds against which the project actions can be assessed.

Component	*Criterion*	*Threshold of concern*	*Action or alternative*
Human health	noise level	maximum 12 dB increase	_____
Economics	benefit-cost ratio	2:1	_____
Water supply	withdrawal rate	125,000 litres/day	_____

Impact evaluation and determination of significance

Summary of Worst-Case Potential Impacts Prior to Mitigation

Impact Rating – = No impact 0 = Negligible impact 1 = Minor impact 2 = Moderate impact 3 = Major impact **Project Component**	*Physical facilities*	*Atmospheric emissions*	*Liquid and solid releases*	*Noise*	*Lights and beacons*	*Additive impacts*	*Repetitive impacts*
Environmental Components							
Marine Plants							
Phytoplankton	0	–	0	–	–	0	–
Macrophytes	–	–	–	–	–	–	–
Microbiota							
Water column	0	0	1	–	–	1	–
Sediments	0	0	1	–	–	0/1	1
Zooplankton	0	–	0/1	–	–	1	–
Ichthyoplankton	0	–	1	–	–	1	–
Macrobenthos							
Hyperbenthos	1	–	0	–	–	0	–
Epibenthos	1	–	1	–	–	1	1
Biofouling Community	1	–	1	–	–	1	1
Fish and Commercial Shellfish							
Pelagics	1	–	0	–	0	0	–
Groundfish	0	–	0	–	–	0	–
Shellfish	0	–	1	–	0	1	1

Figure 4.1 Partial impact identification matrix from the Hibernia offshore oil development project.

Box 4.3 Illustration of a Typical Section of the Leopold Matrix

Matrix instructions:
1. Identify all actions across the top that are part of the proposed project.
2. Under each action, place a diagonal slash in the cell at the intersection of each component on the side of the matrix where an impact is possible.
3. Indicate the magnitude of the impact with a value from 1 to 10 in the upper left of each cell, where 1 is a low and 10 is a high magnitude. Indicate + for a positive impact or – for a negative impact. In the lower right, indicate a value from 1 to 10 for the importance of the impact.

		Components and actions: modification of regime							
		a) exotic flora or fauna introduction	b) biological controls	c) modification of habitat	d) alteration of ground cover	e) alteration of groundwater hydrology	f) alteration of drainage	g) river control and flow modification	h) noise and vibration
A. CHEMICAL CHARACTERISTICS	1. Earth								
	a. mineral resources								
	b. construction material								
	c. soils								
	d. land form								
	e. force fields and radiation								
	f. unique features								
	2. Water								
	a. surface								
	b. ocean								
	c. underground								
	d. quality								
	e. temperature								

For example: –10 (Magnitude (strong negative impact)) / 1 (Importance (minor, perhaps locally contained))

Source: Based on Leopold et al. 1971.

Impact evaluation and determination of significance

Box 4.4 Example of a Simple Weighted Magnitude Matrix

Affected Environmental Components		Weight (importance)	Project actions						Total impact
			blasting	side cleaning	dredging	road construction	waste disposal	equipment transport	
	air quality	0.26	–1			–1	–1		–0.78
	water quantity	0.10	–2	–3	–3				–0.80
	water quality	0.22	–2	–4	–2				–1.76*
	noise	0.04	–2		–1	–2		–2	–0.28
	habitat	0.08		–5		–3			–0.64
	wildlife	0.08	–2	–4		–2			–0.64
	human health	0.22	–2			+3	–3		–0.44

+ = positive impact
– = adverse impact

No impact =
Neglible impact = 1
Minor impact = 2
Moderate impact = 3
Major impact (irreversible or long-term) = 4
Severe impact (permanent) = 5

*Total impact (water quality) = (0.22)(–2) + (0.22)(–4) + (0.22)(–2) = –1.76

In the above matrix, the weights are distributed across the affected environmental components such that the total of all weights is '1', where the larger the weight the more important the component. In this way, all components can be given equal weight, 1/7 in the above matrix, but to increase the importance of one component requires that a trade-off be made and the importance of another component or components be decreased.

Impact evaluation and determination of significance

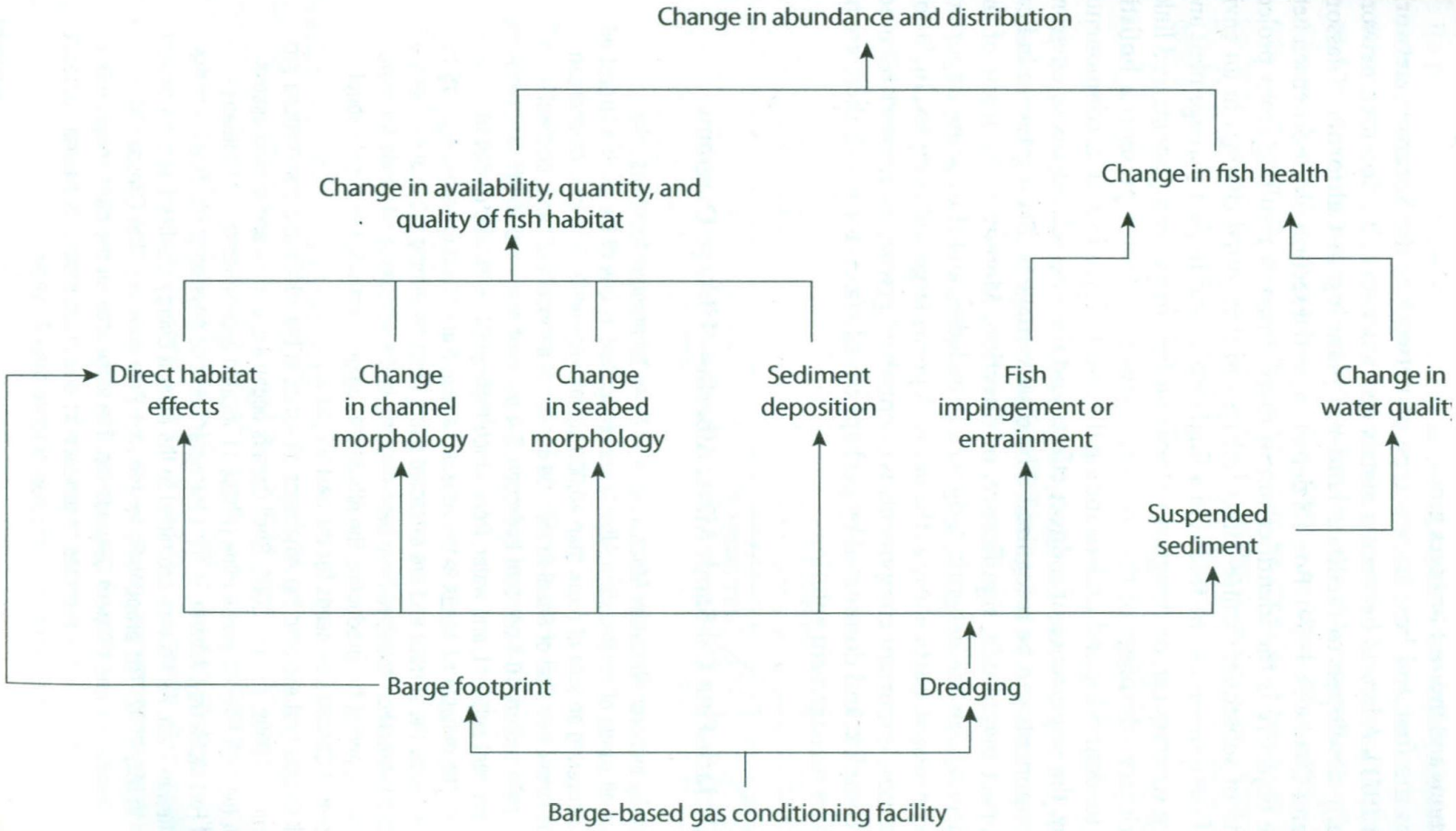


Figure 4.2 Effect pathways network diagram for the Niglintgak Barge Facility of the Mackenzie Gas Project, Northwest Territories.

Source: Adapted from the Mackenzie Gas Project Impact Statement, 2004, v. 5, section 7, Figure 7-8, p. 7-74.

Impact evaluation and determination of significance

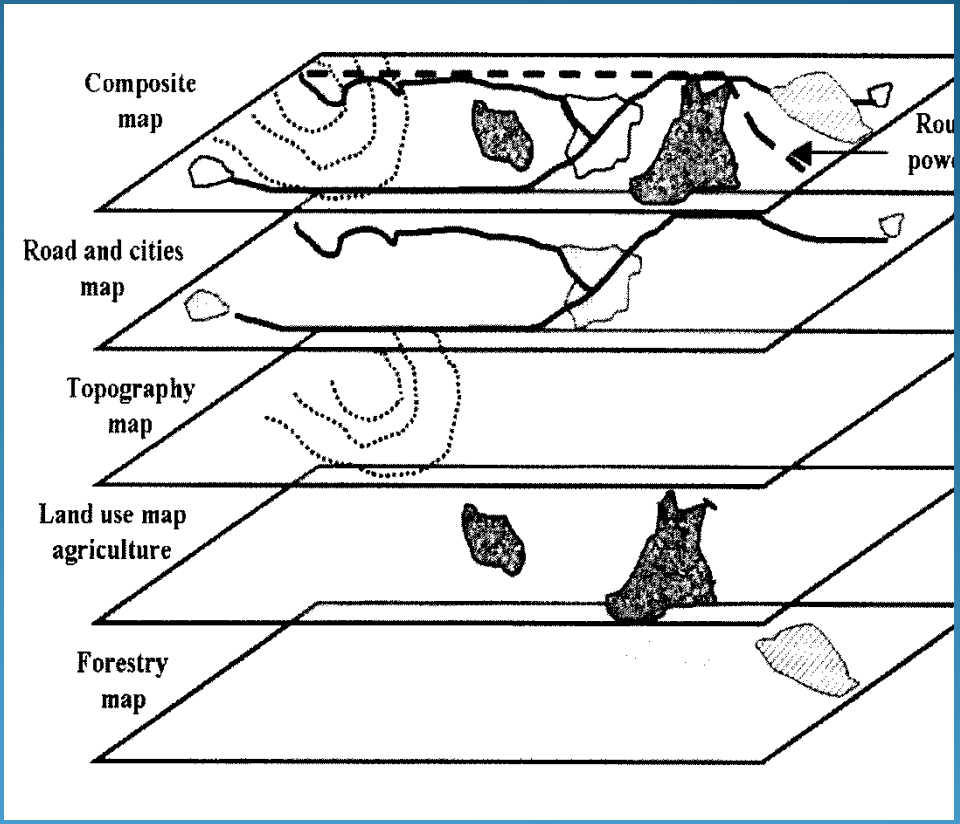
McHarg system - Overlays

Scale is really important:

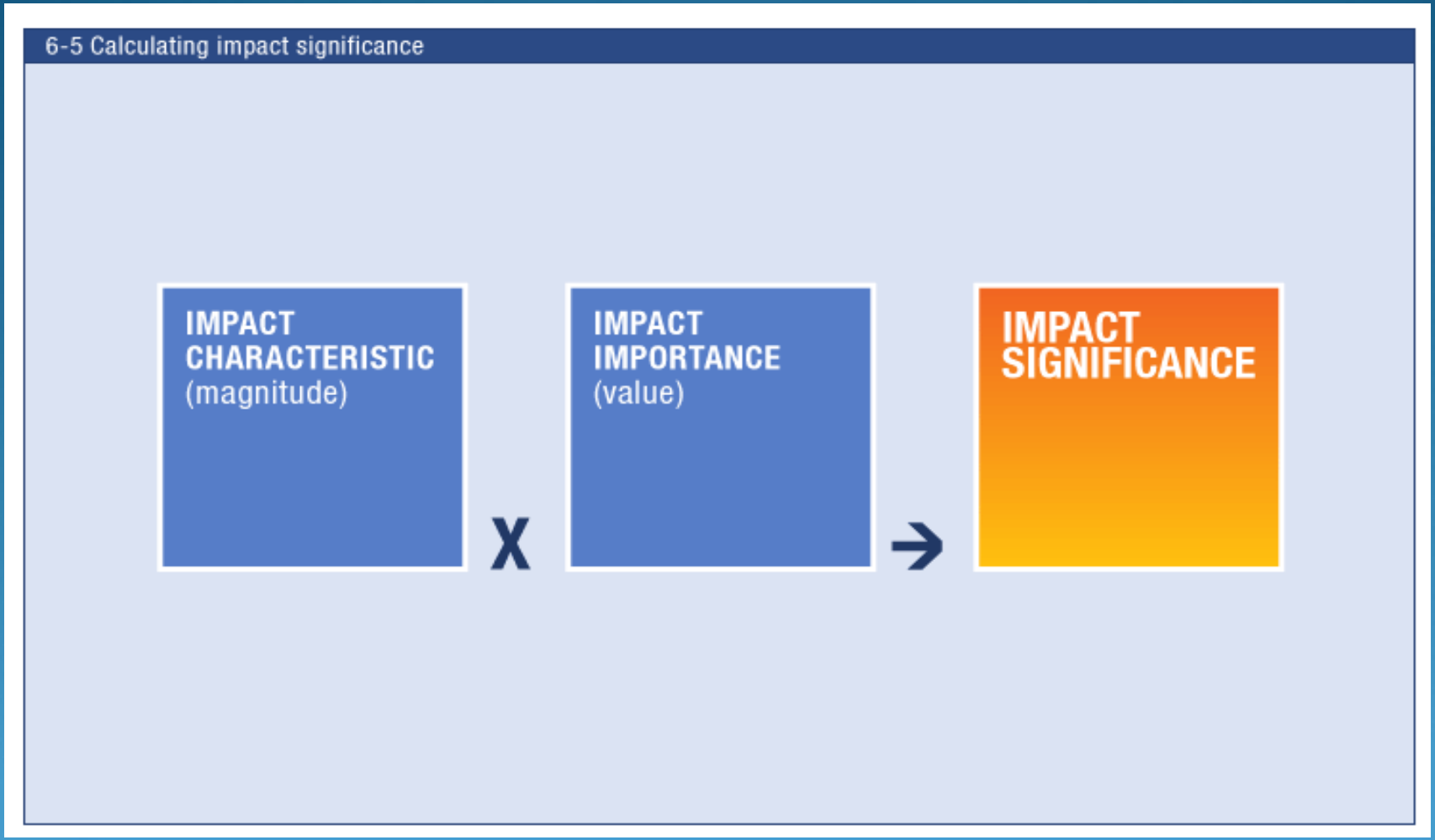
One of two following errors may occur:

1) local impacts absorbed by impacts at a larger scale

2) Small scale impacts are given the same weight as higher scale impacts



Impact evaluation and determination of significance



RAPID IMPACT ASSESSMENT MATRIX (RIAM)

PASTAKIA, 1998
Developed, 2010

Impact evaluation and determination of significance

TABLE 1. Assessment Criteria

Criteria	Scale	Description
A1: Importance of condition	4	Important to national/international interests
	3	Important to regional/national interests
	2	Important to areas immediately outside the local condition
	1	Important only to the local condition
	0	No importance
A2: Magnitude of change/effect	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change/status quo
	−1	Negative change to status quo
	−2	Significant negative disbenefit or change
	−3	Major disbenefit or change
B1: Permanence	1	No change/not applicable
	2	Temporary
	3	Permanent
B2: Reversibility	1	No change/not applicable
	2	Reversible
	3	Irreversible
B3: Cumulative	1	No change/not applicable
	2	Non-cumulative/single
	3	Cumulative/synergistic

Impact evaluation and determination of significance

$$(a1) \times (a2) = aT$$

$$(b1) + (b2) + (b3) = bT$$

$$(aT) \times (bT) = ES$$

$$A_T = A1*A2$$

$$B_T = B1 + B2 + B3 + B4$$

$$ES = A_T*B_T.$$

Impact evaluation and determination of significance

TABLE 2. Conversion of Environmental Scores to Range Bands

Environmental Score	Range Bands	Description of Range Bands
+72 to +108	+E	Major positive change/impacts
+36 to +71	+D	Significant positive change/impacts
+19 to +35	+C	Moderately positive change/impacts
+10 to +18	+B	Positive change/impacts
+1 to +9	+A	Slightly positive change/impacts
0	N	No change/status quo/not applicable
−1 to −9	−A	Slightly negative change/impacts
−10 to −18	−B	Negative change/impacts
−19 to −35	−C	Moderately negative change/impacts
−36 to −71	−D	Significant negative change/impacts
−72 to −108	−E	Major negative change/impacts

sessment criteria (applying Pastakia, 1998; Kuitunen et al., 2008).

iteria	Scale	Description
. Importance of the impact	4	Important to national interests: area of coverage can be defined as the country as a whole, or the impact target has national/international significance.
	3	Important regionally: area of coverage can be defined as a single region of the country with its immediate surroundings, e.g. Central Finland as a whole.
	2	Important to areas outside the local context: area of coverage can be defined as a part of the region, but nevertheless is bigger than in local impacts. For example, a municipality as a whole.
	1	Important only in the local context: area of coverage is small and can be defined as point-formed, for example a single village inside a municipality.
	0	No geographical or other recognised importance.
. Magnitude of change	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change in status quo
	−1	Negative change to status quo
	−2	Significant negative disadvantage or change
	−3	Major disadvantage or change
. Permanence of the impact-causing activity	4	Permanent or long-term: the impact is intended to be a permanent one or will last for more than 10–15 years.
	3	Temporary and medium-term: the impact will last approximately 1–10 years
	2	Temporary and short-term: the impact will last only for a short period of time (few weeks or mont
	1	No change/not applicable
. Reversibility of impact	4	Irreversible impact: impact has changed the environment permanently or the restoration will last at least 10–15 years.
	3	Slowly reversible impact: impact has changed the environment substantially but restoration can be observed. Total recovery will, however, last for many years.
	2	Reversible impact: the original state of the environment will be restored quickly (in weeks or mont after the activity finishes.
	1	No change/not applicable
. Cumulativity/synergism of impact	4	Impact has obvious cumulative or synergistic effects with the other projects or activities occurring in the same area.
	3	Cumulative and/or synergistic impacts exist in the project environment, but the significance of thes interactions is still uncertain.
	2	Impact can be defined as single (not interacting with other impacts)
	1	No change/not applicable
. The susceptibility of the target environment	4	The target area is extremely sensitive to environmental changes and/or it has intrinsic values with regional or national level significance
	3	The target area is sensitive to environmental changes and/or it has locally significant intrinsic value (outside the actual target area)
	2	The area is stable for the environmental changes caused by the planned project and does not have significant environmental values that should be considered during the evaluation process
	1	No change/not applicable

Impact evaluation and determination of significance

Range bands used for the modified RIAM method.

ES scores	Classification	Description
[108, 192]	+4	Major positive impact
[54, 107]	+3	Significant positive impact
[31, 53]	+2	Moderate positive impact
[1, 30]	+1	Slight positive impact
0	0	No change in status quo
[−30, −1]	−1	Slight negative impact
[−53, −31]	−2	Moderate negative impact
[−107, −54]	−3	Significant negative impact
[−192, −108]	−4	Major negative impact

- An impact represents the lower limit of a major change, if it is regionally important (A1 = 3) and causes major changes in its area of influence (A2 = 3). In addition both the duration and reversibility of the impact can be measured in years (B1 = B2 = 3), the impact accumulates over time or has synergistic effects with other environmental impacts (B3 = 3), and it focuses on areas of the environment susceptible to changes (B4 = 3).
- When an impact is significant outside the local context (A1 = 2), causes major changes in this area (A2 = 3) and focuses on sensitive areas of the environment (B4 = 3), but the consequences can still be defined as temporary and short-term (B1 = 2), reversible (B2 = 2) and single/non-cumulative (B3 = 2), it presents the lower limit of significant change.
- A condition is placed on the upper limit of slight change, if it is only locally important (A1 = 1) but causes significant changes (A2 = 2) that are permanent (B1 = 4), irreversible (B2 = 4), highly cumulative/synergistic (B3 = 4) and focus on a sensitive area of the environment (B4 = 3).
- Impacts of moderate significance lie between the limits of slight and significance change.
- Impacts that have no importance (A1 = 0) or do not change the status quo (A2 = 0) are scored zero.

Physical and chemical components (PC)		A1	A2	B1	B2	B3	ES	RV
PC1	Air quality	2	-1	2	2	2	-12	-B
PC2	Noise	1	-2	3	2	1	-12	-B
PC3	Groundwater	1	-2	3	2	2	-14	-B
PC4	Surface water	1	-2	2	2	2	-12	-B
PC5	Land use	2	-1	2	2	1	-10	-B
PC6	Subsidence	1	-1	3	3	1	-7	-A
PC7	Visual impacts	1	1	1	1	1	3	A
PC8	Soil pollution	3	-1	3	2	1	-18	-B
Biological and ecological components (BE)								
BE1	Fauna	2	-1	3	2	1	-12	-B
BE2	Flora	2	-1	3	2	1	-12	-B
BE3	Vegetation	2	-2	2	2	1	-20	-C
BE4	Habitat lose	1	-1	1	1	1	-3	-A
Sociological and cultural components (SC)								
SC1	Culture	2	1	3	2	2	14	B
SC2	Education	2	2	3	2	2	28	D
SC3	Archeology	1	1	1	1	1	3	A
SC4	Science	3	2	3	2	2	35	D
SC5	Recreations	2	-1	1	1	1	-6	-A
SC6	Migration	2	2	3	1	1	20	C
Economical & operational components(EO)								
EO1	Jobs	3	3	3	1	1	45	D
EO2	Access road	2	3	3	1	1	30	C
EO3	Public services	3	3	3	2	1	54	D
EO4	Tourism	3	3	3	2	1	54	D
EO5	Land prices	1	3	3	2	1	18	B
EO6	Agriculture	3	-1	2	2	1	-15	-B
EO7	Transportation	3	2	3	2	1	36	D

Table 4. Summary of assessment

ES	RV	RVN	PC	BE	SC	EO	Total	Final	%
72 to 108	E	5	0	0	0	0	0	0	0
36 to 71	D	4	0	0	1	4	5	20	33
19 to 35	C	3	0	0	2	1	3	9	15
10 to 18	B	2	0	0	1	1	2	4	6
1 to 9	A	1	1	0	1	0	2	2	3
0	N	0	0	0	0	0	0	0	0
-1 to – 9	-A	-1	1	1	1	0	5	-5	8
-10 to -18	-B	-2	6	2	0	1	9	-18	30
-19 to -35	-C	-3	0	1	0	0	1	-3	5
-36 to -71	-D	-4	0	0	0	0	0	0	0
-72 to -108	-E	-5	0	0	0	0	0	0	0

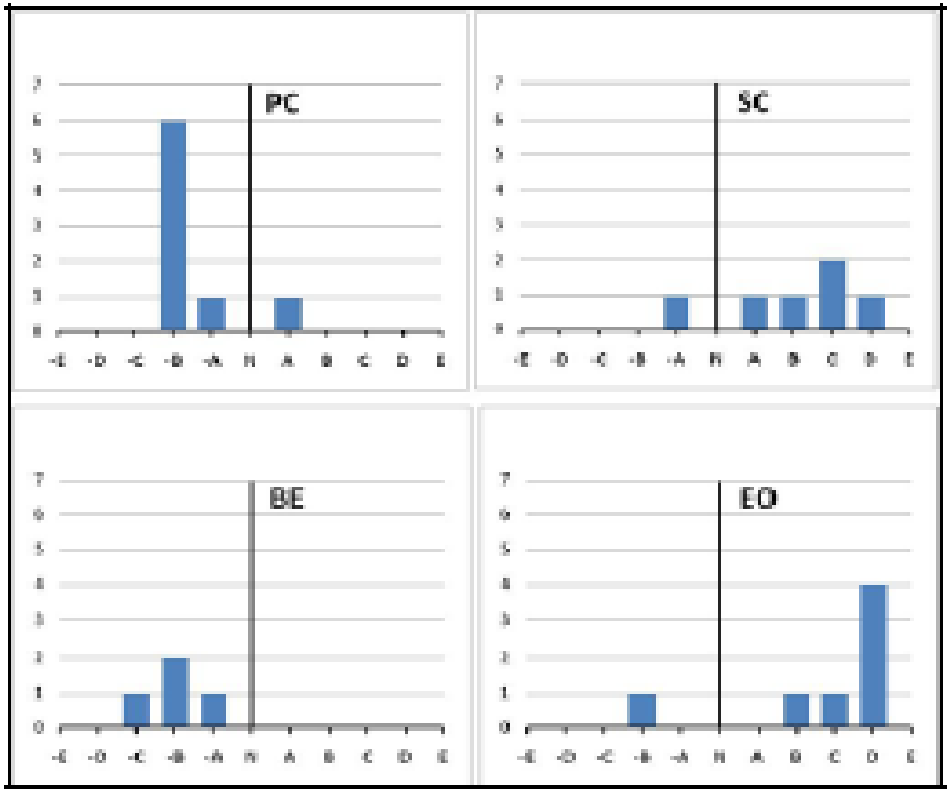


Figure 4. Comparison of positive and negative impacts in and between the categories

- Physical/Chemical (PC)
  Covering all physical and chemical aspects of the environment.
- Biological/Ecological (BE)
  Covering all biological aspects of the environment.
- Sociological/Cultural (SC)
  Covering all human aspects of the environment, including cultural aspects.
- Economic/Operational (EO)
  Qualitatively to identify the economic consequences of environmental change, both temporary and permanent.

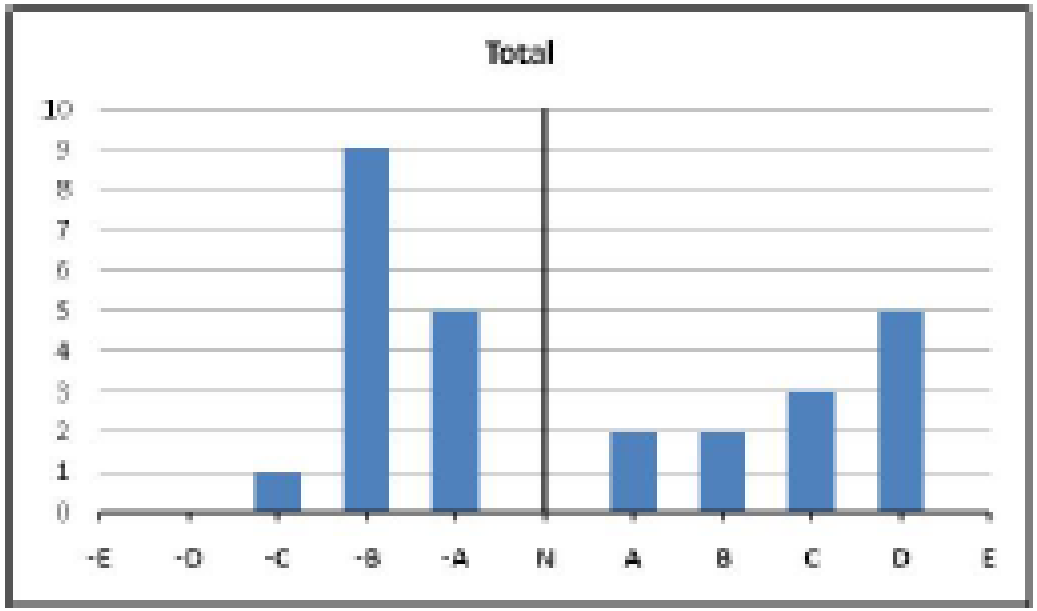


Figure 5. Comparison of total number of positive and negative impacts in the categories

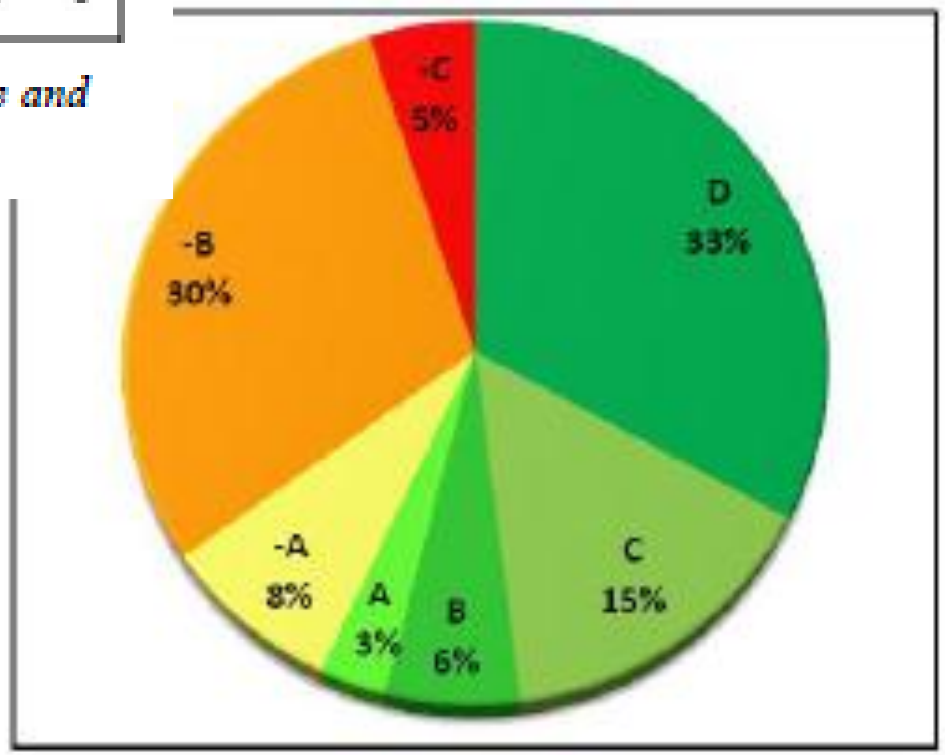


Figure 6. Final results of EIA of Sabalan GPP

Impact evaluation and determination of significance

$$MED_{ij} = \frac{1}{27}(M_{ij} + E_{ij} + D_{ij}) \quad (1)$$

$$SAC_{ij} = \frac{1}{27}(S_{ij} + A_{ij} + C_{ij}) \quad (2)$$

where: M_{ij} = magnitude, E_{ij} = spatial extent, D_{ij} = duration, S_{ij} = synergy effects, A_{ij} = cumulative effects and C_{ij} = controversy. As

Impact evaluation and determination of significance

The expressions and their value in the ordinal scale are: null (0), null to low (1), very low (2), low (3), low to moderate (4), moderate (5), moderate to high (6), high (7), very high (8), and extremely high (9). An exception, in

Impact evaluation and determination of significance

supplementary criteria (SAC_{ij}). In short, the impact (I_{ij}) should be equal to MED_{ij} if the value of SAC_{ij} is zero, but it should be higher than MED_{ij} when SAC_{ij} is greater than zero (Figure 1). In mathematical terms, this relationship can be written as:

$$I_{ij} = MED_{ij}^{\varphi} \qquad (3)$$

where $\varphi = 1\text{-}SAC_{ij}$.

Additionally, the significance of the interaction (G_{ij}), which takes into consideration the mitigation measures (T_{ij}), is obtained from the following equation:

$$G_{ij} = I_{ij} \cdot [1 - (T_{ij}/9)] \qquad (4)$$

Impact evaluation and determination of significance

Table 1. Example of the application of the basic, supplementary, impact and significance indices for the assessment of environmental impacts of La Venta-Colegio Militar highway project in Mexico City

i	j	M_{ij}	E_{ij}	D_{ij}	S_{ij}	A_{ij}	C_{ij}	T_{ij}	MED_{ij}	SAC_{ij}	I_{ij}	G_{ij}
Urban growth rate	Highway operation	3	5	7	3	2	9	6	0·56	0·52	0·75	0·25
Loss of natural cover	Construction/ roadwork	6	2	9	2	2	9	7	0·63	0·48	0·79	0·17
Flora and fauna extinction	Deforestation	2	2	1	3	3	7	6	0·19	0·48	0·42	0·14
Groundwater recharge	Highway surface	1	1	9	0	2	9	9	0·41	0·41	0·59	0·00
Air pollution	Construction and transit	1	1	6	3	1	3	0	0·30	0·26	0·41	0·41

i, environmental factor or effect on; j, activity or cause over; M_{ij}, magnitude; E_{ij}, extention; D_{ij}, duration; S_{ij}, synergy; A_{ij}, cumulative effects; C_{ij}, controversy; T_{ij}, mitigation measure; MED_{ij}, basic index; SAC_{ij}, supplementary index; I_{ij}, impact; G_{ij}, significance.

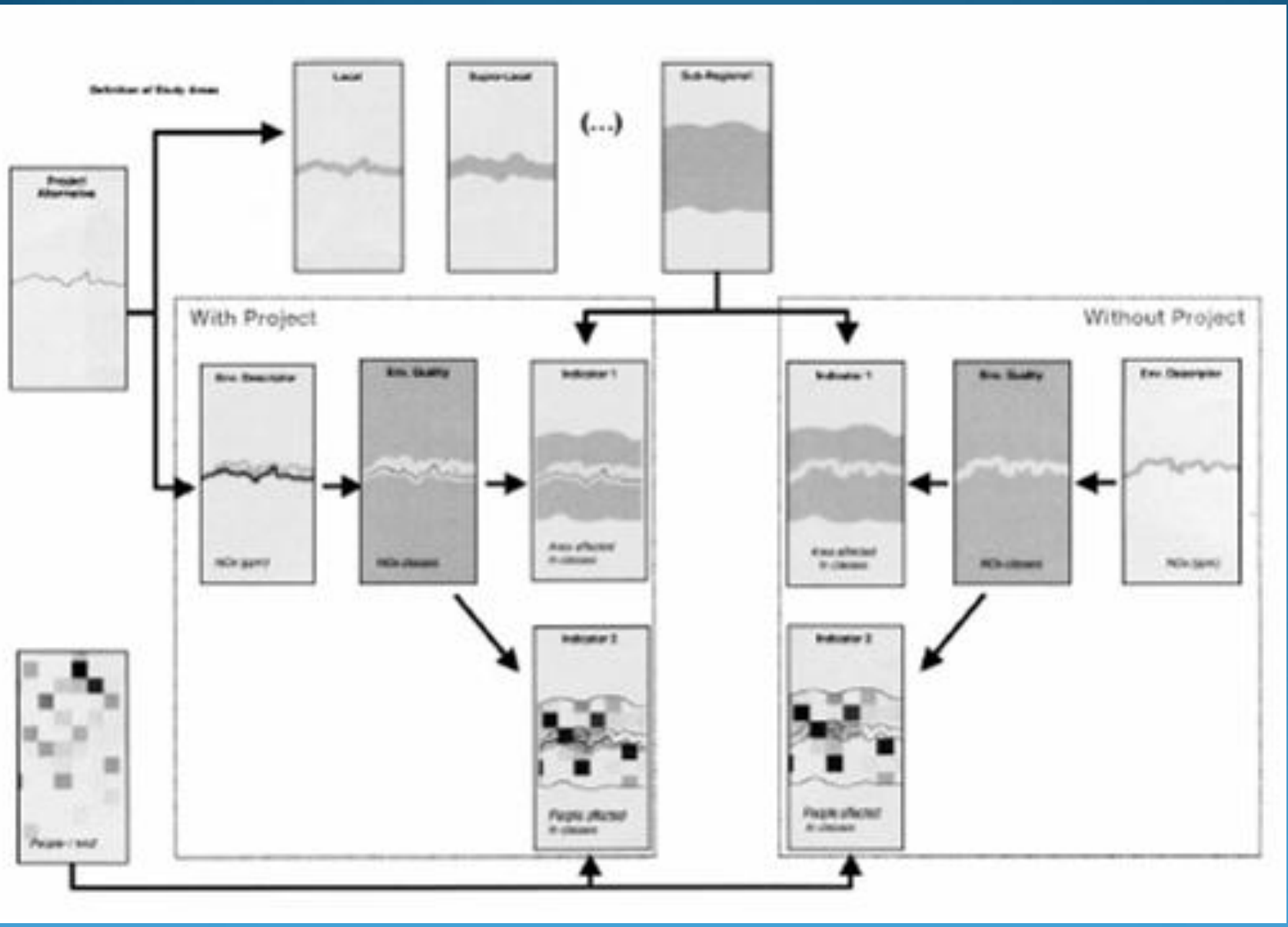
Impact evaluation and determination of significance

Table 3. Number of interactions by value class per project activity of the La Venta-Colegio Militar highway project

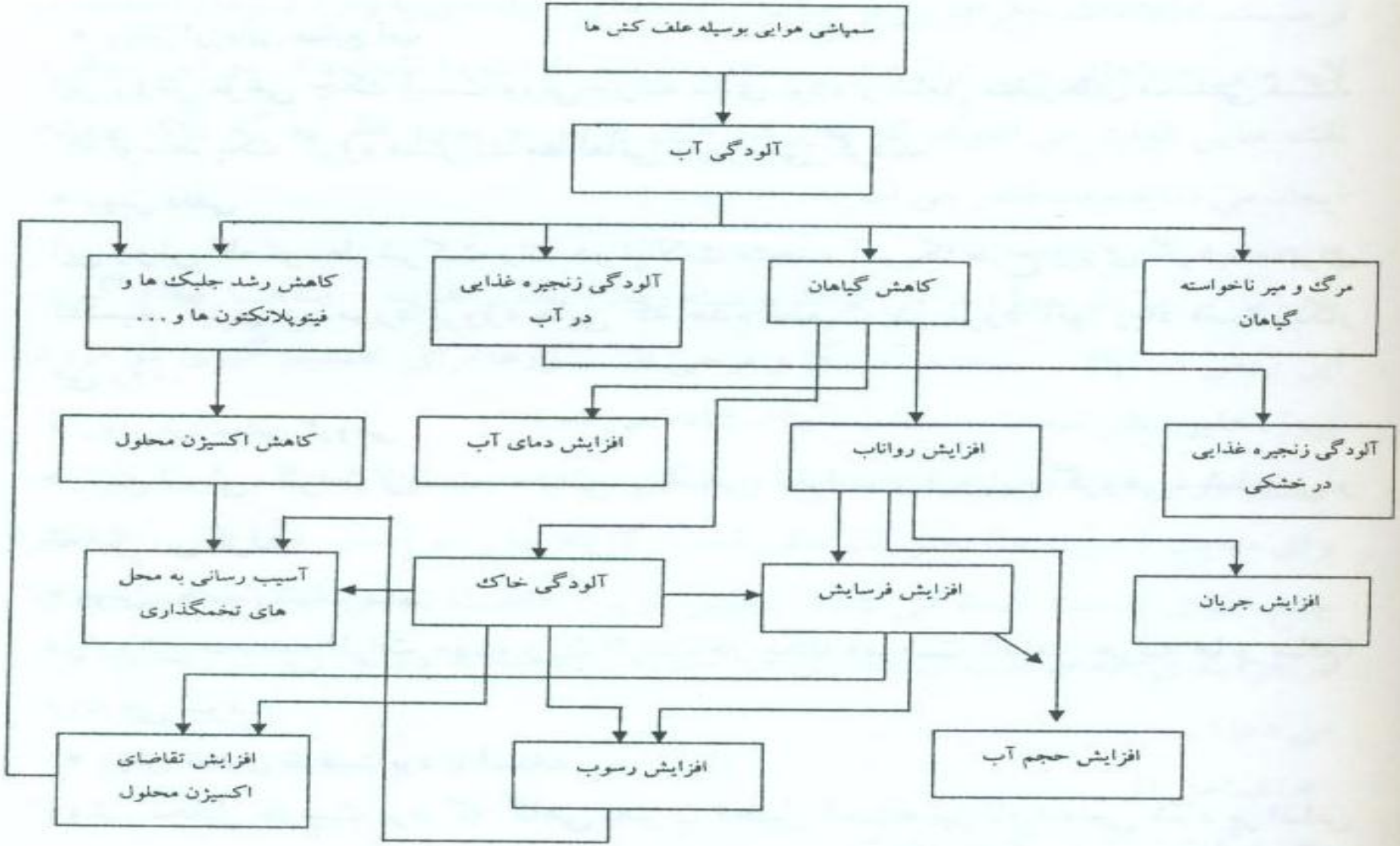
Project activity	Impact (I_{ij})				Significance (G_{ij})			
	L	M	H	VH	L	M	H	VH
Land acquisition	0	0	5	6	7	2	1	1
Access roads	0	10	0	2	2	10	0	0
Clearing of trees	0	5	1	13	13	5	1	0
Soil removal	0	6	0	1	3	4	0	0
Excavations	0	5	0	4	3	4	1	1
Soil compaction	0	4	0	0	0	4	0	0
Slope protection	0	4	1	0	0	4	1	0
Land fillings	0	5	0	0	1	4	0	0
Land cuts/embankments	0	8	0	5	3	8	2	0
Liquid-waste disposal	0	5	0	0	1	4	0	0
Explosions	0	9	1	0	8	2	0	0
Mining of materials	0	6	0	0	2	4	0	0
Tunnels and bridges	0	6	0	3	3	5	0	1
Walls	0	4	0	0	0	4	0	0
Junction (construction)	0	4	2	0	1	4	1	0
Reforestation	0	4	0	0	0	4	0	0
Pavement (building)	0	4	1	0	0	5	0	0
Power lines	0	0	1	0	0	0	1	0
Traffic	0	5	8	4	9	7	1	0
Energy and fuel	0	0	3	0	3	0	0	0
Services	0	0	4	1	4	1	0	0
Junctions (operation)	0	0	3	2	2	1	2	0

Value classes are the following: low ($L<0{\cdot}25$); moderate ($0{\cdot}25 \leq M<0{\cdot}50$); high ($0{\cdot}50 \leq H<0{\cdot}75$); and very high ($0{\cdot}75 \leq VH<1{\cdot}00$).

SIAM - Case study: A highway in Central Portugal



EIA methods: Networks



شکل (٤-٤٥) نمونه یک شبکه اثرات

EIA methods: Bayesian networks

- Bayesian networks are also known as belief networks, causal networks, probabilistic networks, or Markov random fields

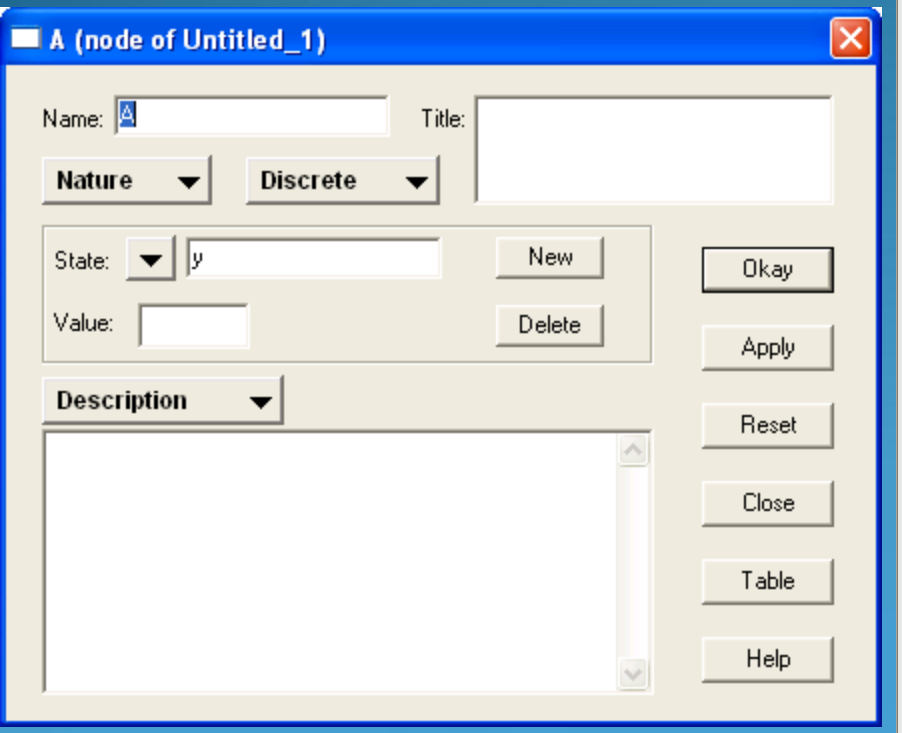
- A Bn consists of a set of variables, represented as *nodes*, which are connected by directed links, represented as *arrows* or *arcs*

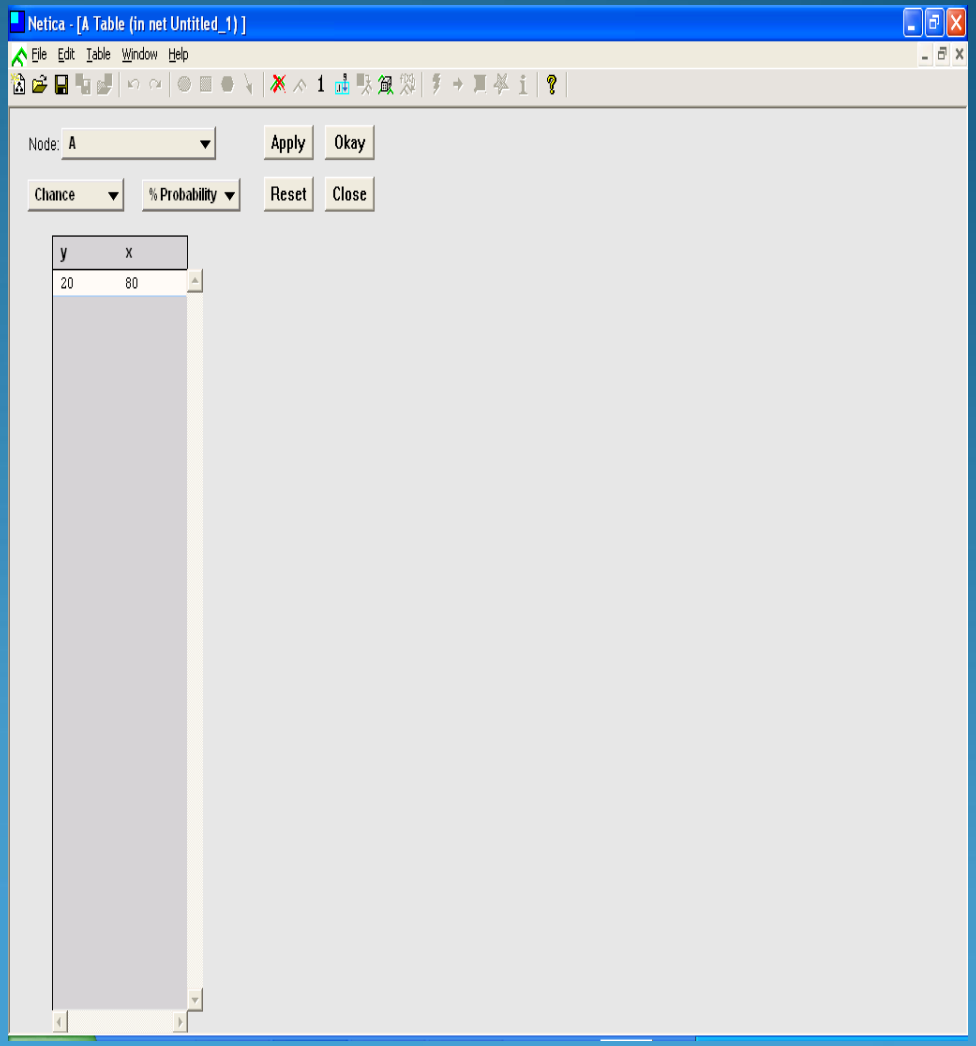
- In general, a Bn is a Directed Acyclic Graph (DAG) representing causal relationships between variables by arrow connections and allowing evaluations of conditional dependences between variables

Bayes rule describes the relationship between the two conditional probabilities between $p(A|B)$ and $p(B|A)$:

$$p(A|B) = \frac{p(B|A)p(A)}{p(B)}$$

EIA methods: Bayesian networks





EIA methods: Bayesian networks