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Risk assessment approach in Serbia for land-use planning process

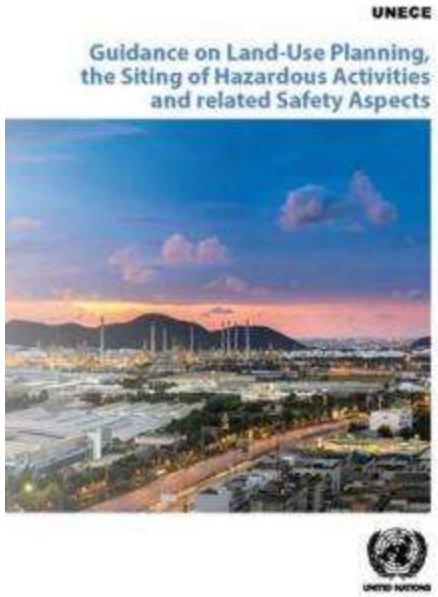
Sanja Stamenkovic

Ministry of Environmental Protection

Republic of Serbia

RISK ASSESSMENT APPROACH FOR LAND-USE PLANNING PROCESS

The land use planning approaches can be grouped under four categories:



a. **Deterministic approach:** defines generic distances which are determined by the kind of hazardous activity considered, operational acquired experience, environmental impact and expert judgment;

b. **Consequence-based approach:** identifies worst-case potential consequences and evaluates the effects (e.g., fatalities and injuries to individuals);

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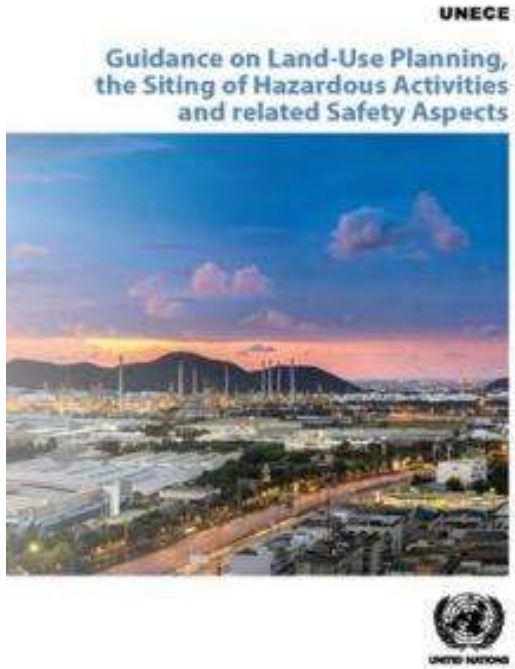

c. **Risk-based approach:** assesses both the consequences and frequency of the accident occurrence to evaluate the individual and/or societal risk;

d. **Semi-quantitative (or semi-probabilistic) approach:** a method based on a quantitative evaluation of the consequence and a qualitative estimation of its occurrence frequency.

Hybrid approaches combining two or more of the methods above are also used.

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Methodology of the Safety Report development/Risk assessment approach in Serbia

Semi-quantitative (or semi-probabilistic) approach: a method based on a quantitative evaluation of the consequence and a qualitative estimation of its occurrence frequency

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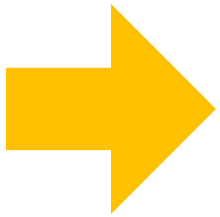
Methodology of the Safety Report development/Risk assessment approach in Serbia



✓As proscribed by Law on Environmental Protection, all upper tier establishments are required to draft a Safety Report and submit it to CA for evaluation.

✓Threshold values for dangerous substances defining upper tier establishments are transposed from Annex I of EU Seveso III directive.

✓ Data from Safety Report is a base for determining zones for risk assessment and possible transboundary effects.

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Methodology of the Safety Report development/The content of the Safety Report

Introduction
Major Accident Prevency Policy (MAPP)
Safety Management System (SMS)
Description of the establishment and its environmental
Hazard Identification
Scenario
Consequences Analysis
Prevention measures

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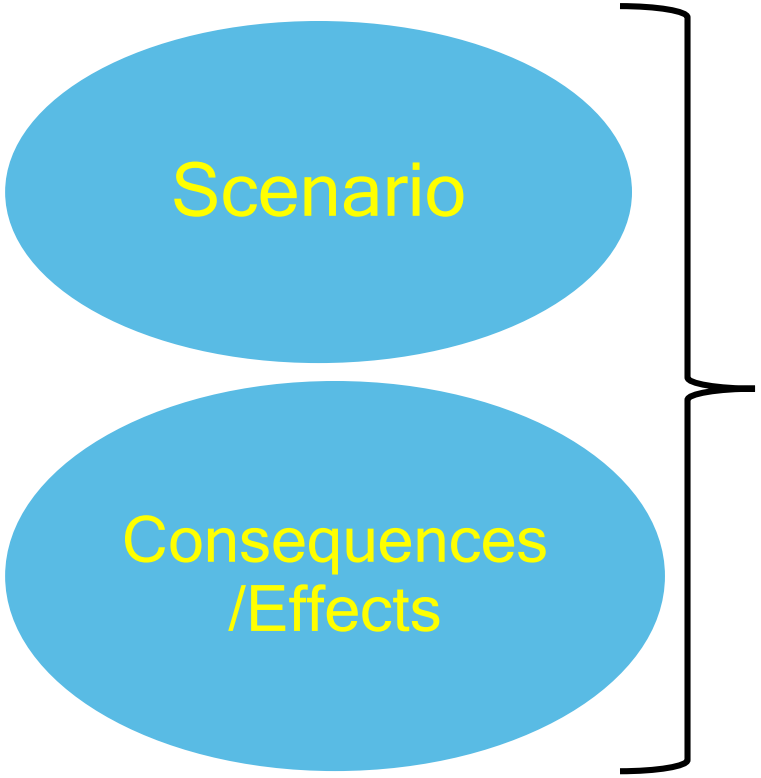

✓Scenarios should be chosen on the basis of identified critical points and characteristics of dangerous substances, as well as effects that may arise mostly (explosion, fire, toxic release).

✓**The worst case scenario is selected with the greatest consequences for human health and the environment.**

✓When drawing up the worst case scenario, all preventive measures are set as "failed".

✓**If at the establishment various types of effects may happen (physical, toxic, environmental), worst case scenario is drawn up for every type of effects.**

✓There is no limit set on number of scenarios to draw up, but later in process operator analyses and determines for which ones he must model the effects.

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Scenario

The following data and parameters are required for model design/ Scenario

1. Quantities of dangerous substances and their properties (from safety data sheets);
2. Possible effects that each substance can have in case of accident (explosion, fire, toxic release);
3. Information about the area in which accident will occur (indoor or open space, characteristics of the terrain, inhabited or not);
4. Meteorological conditions: Wind speed and atmospheric stability (WCS – wind 1.5 m/s and atmospheric stability of "F" class, all other – wind 2-3 m/s and atmospheric stability of "D" class, but for locations where there are statistical data that the prevailing condition of the atmosphere is silence and/or inversion, they should be taken for modeling the effects); Outside temperature and humidity (If the WCS does not require the highest daily temperature, the temperature that determines maximum effects of the given scenario should be used. For other cases, data for medium annual temperatures should be used.)

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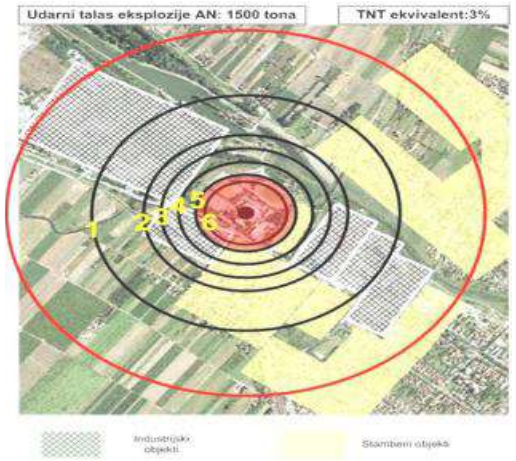
Consequences/ Effects



- Flash fire (vapour propagation zones, domino/escalation zone, thermal zones for 50% death, 1% death, I degree burns and safety zones);
- BLEVE-Boiling Liquid Expanding Vapour Explosion (characteristics of fire ball, thermal zones for 50% death, 1% death, I degree burns, safety zones);
- Pool Fire and Jet fire-(characteristics of flame, domino/escalation zone, thermal zones for 50% death, 1% death, I degree burns, safety zones);
- Detonation (overpressure zones for 50% deaths, 50% lung damage, 50% and 1% eardrum rupture, total, severe, moderate and light destruction of objects);
- VCE -Vapour Cloud Explosion (domino/escalation zone, overpressure zones for total and partial destruction of objects, thermal zones for 50% death, 1% death, I degree burns, safety zones);
- Toxic dispersion (LC50 Lethal concentration,IDLH, 0,1 IDLH).

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OVERPRESSURE

THERMAL RADIATION

TOXICITY

- The risk of fatality increases with the level of consequence. The relationship between the level of consequence and the probability of fatality is generally characterized by a probit relationship (a range of responses can be expected in a population exposed to an acute hazard).

- Probit equations do this and can be used to estimate the proportion of the population that may be affected by exposure to a particular harm.

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OVERPRESSURE

One of the most commonly used probits to determine the individual risk (risk to human life) from overpressure is the Hurst, Nussey and Pape (1989) probit.

The probit relationship is generally quoted as:

$Y = 1.47 + 1.35 \ln (P)$

P is the peak overpressure in mbar

This relationship only applies to people exposed outdoors.

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THERMAL RADIATION

The probity most commonly used to determine the individual risk (risk to human life) from thermal radiation is the Eisenberg et al (1975) probit, i.e.

$$Y = -14.9 + 2.56 \ln (I^{4/3} t)$$

Y is the probit

t is duration of exposure (sec)

I is thermal radiation intesity I in kW/m^2

This relationship applies to people exposed outdoors. However, it can be reasonably applied for most exposed populations (whether indoor or outdoor).

In terms of thermal radiation, the key contours for structural damage will be (World Bank, 1985)

37,5 kW/m^2	Sufficient to cause damage to process equipment
25,5kW/m^2	Minimum heat flux to ignite wood at indefinitely long exposures (non piloted)
12,5 kW/m^2	Minimum heat flux for piloted ignition of wood, melting of plastic tubing

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Probit Equation Constants for Lethal Toxicity

The probit equation is of the form

$Y = a + b \ln(C^n t)$

Y is the probit

a, b, n are constants

C is the concentration in ppm

t is the exposure time in minutes

Remark: A variety of probits exist in the published literature for some substances; therefore it is often necessary to make a selection. In general, it is currently recommended that probits be selected from the most well established sources.TNO is a Dutch technical research organisation, AIChE is the American Institute of Chemical Engineers and HSE is the UK Health and Safety Executive.

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Effects	Consequences for which values and limits are required in the Rulebook of Serbia	Examples of endpoints for the consequences of the accident effects specified in the Rulebook of Serbia
Explosion/ overpressure	Lethal outcome/ severe lung damage (in approximately 50% cases)	10 bar
	Eardrum rupture (in approximately 50% cases)	1000 mbar
	Eardrum rupture (in approximately 1% cases)	225 mbar
	Complete demolition of facilities	850 mbar
	Moderate damages to facilities	400 mbar
	Light damages to facilities	175 mbar
Fire and explosion/ thermal radiation	Lethal effects (in approximately 50% cases)	11.2 kW/m² (40") or 31.6 kW/m² (10") (e.g. BLEVE)
	Lethal effects (in approximately 1% cases)	5.6 kW/m² (40") or 15.9 kW/m² (10") (e.g. BLEVE)
	First degree burns	4.3 kW/m² (40") or 12 kW/m² (10") (e.g. BLEVE)
	Transfer of fire to other facilities (depending on the type of material)	37,5kW/m²
Toxicity	LC50 (lethal concentration) (30 minute exposure)	
	IDLH (Immediately Dangerous to Life or Health)	
	0.1 IDLH	

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CONSEQUENCE ANALYSIS

The consequence analysis includes modelling the effects of accident, vulnerability analysis and determining the possible level of accident, followed by risk assessment.

According to the defined scenarios, the effects of accidents are modelled and vulnerability zones are determined.

In the vulnerability analysis, it is necessary to identify and report all endangered objects in the vicinity of establishment and within the vulnerable zones.

Risk assessment includes the assessment of the likelihood of the occurrence of the accident, the assessment of possible consequences and the determination of the acceptability of the risk.

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Accident probability assessment is performed in one of the following ways:
based on statistic data –historical approach (source of data must be stated);
based on hazard identification –analytical approach;
by combining historical and analytical approach.
The probability is numerically or descriptively expressed as low, medium and high.
The following table may be used if no other data is available:

Criteria for accident probability assessment

High probability (10^{0} – 10^{-1} frequency of the occurrence/yr)	Medium probability (10^{-1} – 10^{-2} frequency of the occurrence/yr)	Low probability ($<10^{-2}$ frequency of the occurrence/yr)
• leakage of hazardous substances at pipe joints, valves, etc. • spillage in liquids decanting and dispersal of solid substances in manipulation • damages made to unit packaging and spillage of contents • leakage of liquids and dispersal of solid substances in internal transport • leakage of gases under pressure from pipelines and other pressurised systems • created conditions for fire of explosion in Hazard ZONE 2 • initial fire in plants	• liquid substances pipeline breakage • pressurised gas pipeline breakage • spillage of the whole contents from the tank storing liquids • spillage from vehicle and train tanks in the establishment after breakdowns • created conditions for fire of explosion in Hazard ZONE 1 • fire and explosion in a part of the establishment • two and more accidents of high probability in one location at the same time	• crack of transport vessels • crack of storage vessels • fire in the whole establishment • fire in the whole establishment • explosion of the whole establishment • explosion of the whole storage • created conditions for fire of explosion in Hazard ZONE 0 • two and more accidents of medium probability in one location at the same time

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Possible consequences to human life and health and environment shall be estimated on the basis of data obtained in vulnerability analysis. Vulnerable facilities shall be numerically expressed, while most serious consequences are taken into account when estimations are made. Criteria for potential consequences assessment are provided for in the following table:
Criteria for potential consequences assessment:

Consequence indicators	**Consequences**				
	Low significance	Significant	Serious	Severe	Catastrophic
Number of casualties with lethal outcome	no	no	1-2	3-5	more than 5
Seriously injured Seriously intoxicated	no	1-2	3-6	7-10	more than 10
Slightly injured Slightly intoxicated	no	1-5	6-15	16-30	more than 30
Dead animals	≤0,5 t	0,5-5 t	5-10 t	10-30 t	more than 30 t
Contaminated soil	≤0,1 ha	0,1-1 ha	1-10 ha	10-30 ha	more than 30 ha
Materialistic damages in thousands RSD	≤100	100 – 1,000	1,000 – 10,000	10,000 – 100,000	higher than 100,000

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Accident risk shall be assessed on the basis of accident probability and potential consequences.

Accident probability	Consequences				
	low significance	significant	serious	severe	catastrophic
low	negligible risk	low risk	medium risk	high risk	very high risk*
medium	low risk	medium risk	high risk	very high risk*	very high risk*
high	medium risk	high risk	very high risk*	very high risk*	very high risk*

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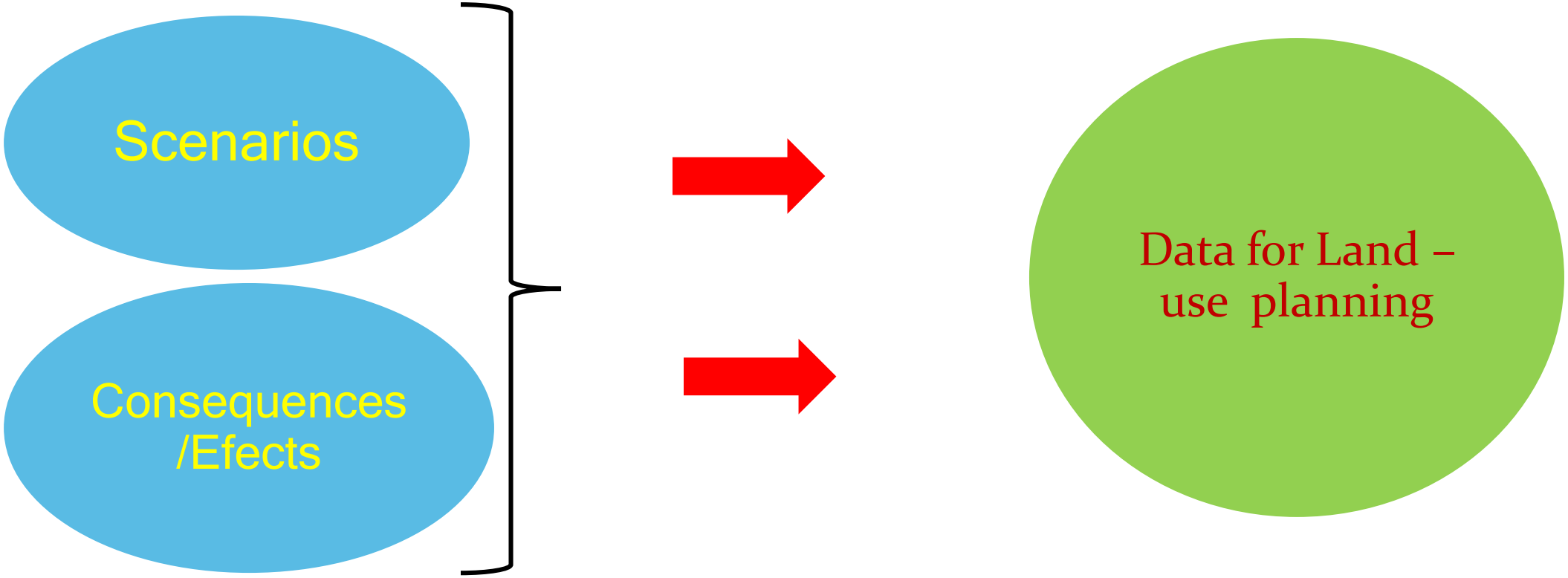

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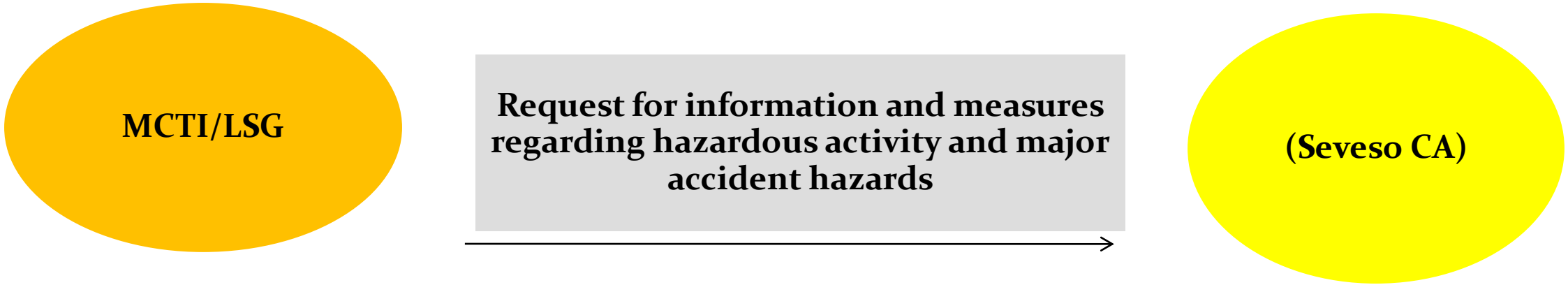

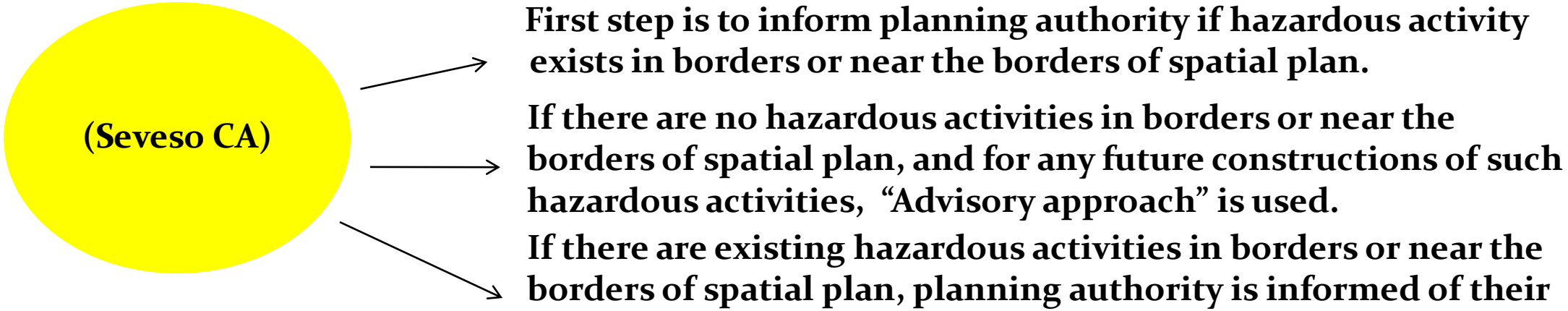

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LOWER TIER

For lower tier establishments, 1.000 meters from its borders is named as vulnerable zone, that zone is used for planning emergency evacuation and it is advised against construction of non-industrial objects and areas.

UPPER TIER

For upper tier establishments, modeled effects of major accidents, for every possible type of effect on that establishment, are used, using endpoints of effects proscribed by Methodology.

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For upper tier establishments modeled effects of major accidents, for every possible type of effect on that establishment are used, using endpoints of effects proscribed by Methodology.

Ban of construction of non-industrial facilities and areas is issued for all 50% casualties zones or IDLH zones.

Also, if industrial facilities are planned in 50% casualties zones or IDLH zones, personal safety equipment and general protection measures from Safety Data Sheets of every hazardous substance present at the establishment, are proscribed as mandatory for all possible industrial investors in that zone (for their personal and visitors).

Other injury zones (1st degree burns, 0,1IDLH etc.) are most often used as vulnerable zone for planning emergency evacuation.

Sometimes but, since it is not proscribed by law, not always, planning authorities return their draft outputs with interventions regarding industrial safety measures for additional comments and additional information

RISK ASSESSMENT APPROACH FOR LAND-USE PLANNING PROCESS

Addressing the challenges:

- Full transposition of the provisions of the Seveso III Directive related to land use planning into national regulations.
- Improving cooperation and coordination between land-use planning and industrial safety authorities and set up appropriate consultation procedures.

THANK YOU FOR YOUR ATTENTION!

Sanja Stamenkovic, Senior adviser
Department for Major Chemical Accident Protection
sanja.stamenkovic@ekologija.gov.rs