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Slide Show on Hierarchical Systems Analysis in Karst Terrains: Part B - Analysis of Environmental Impacts of Aggregate Mining

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Hierarchical Systems Analysis in Karst Terrains:

Part B

Analysis of Environmental Impacts of Aggregate Mining

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Purpose of Presentation

- Describe how the hierarchical systems analysis (HSA) can be used to analyze environmental impacts (for example from the mining process).
- Describe selected environmental impacts from mining aggregate in karst terrain.

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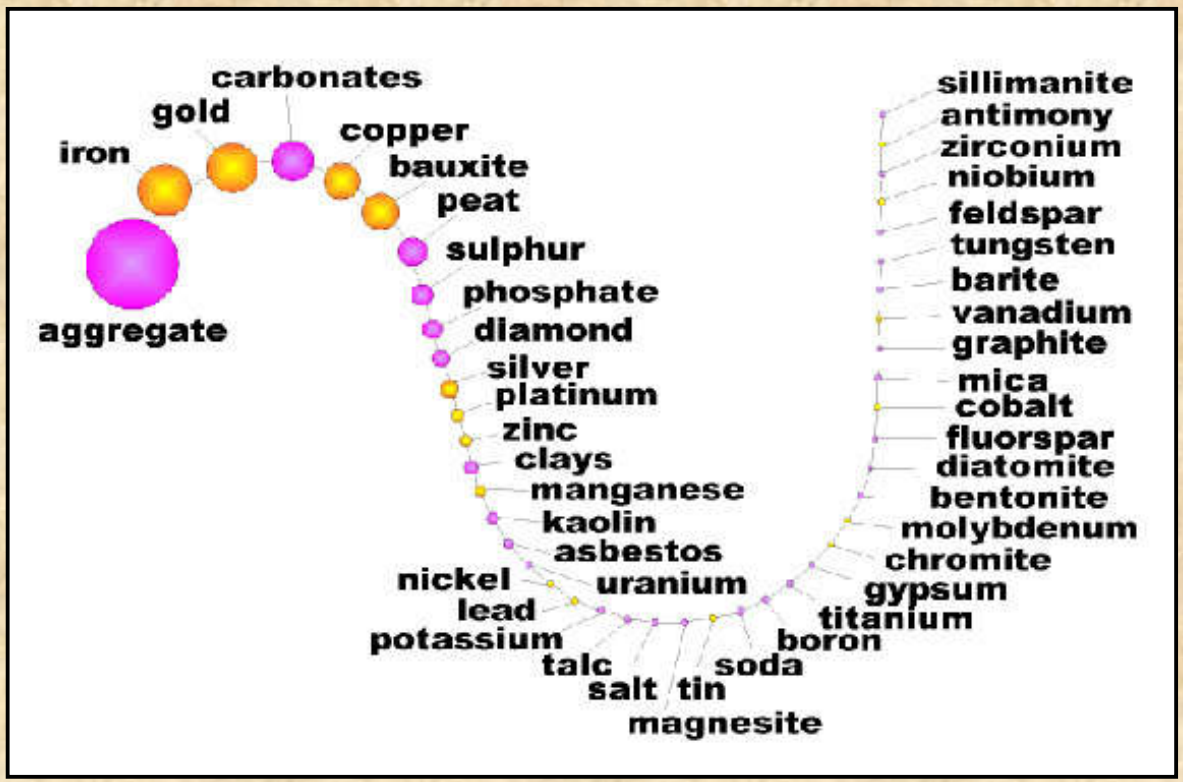
Why Mine Carbonate Rocks?

Carbonates are fourth in terms of value in worldwide production of non-fuel mineral resources.



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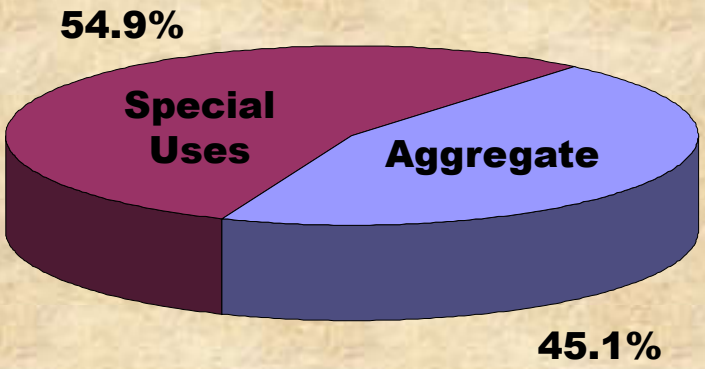
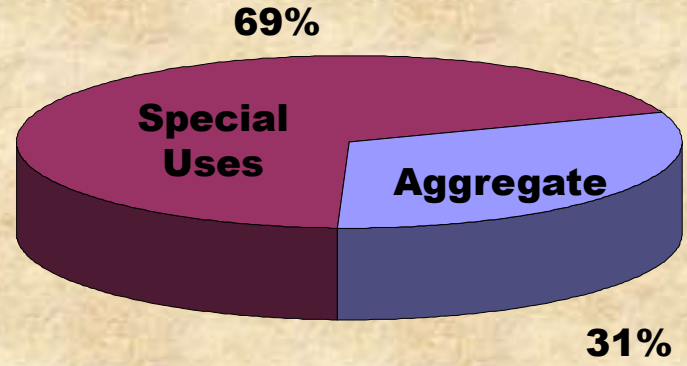
Why Mine Carbonate Rocks?

- Carbonates are only acceptable source of stone for some construction, agricultural, metallurgical, industrial, and environmental uses.



Limestone



Dolomite

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Goal

Provide a continuing supply of high quality carbonate rocks while sustaining environmental quality.

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Why Use Hierarchical Systems Analysis?

- Landscape or site is mosaic of dynamic systems that operate through complex, interrelated processes.
  - Impacts to those systems occurs through complex, interrelated processes.
- Stepwise approach breaks complicated issues into smaller, easier to understand, components.

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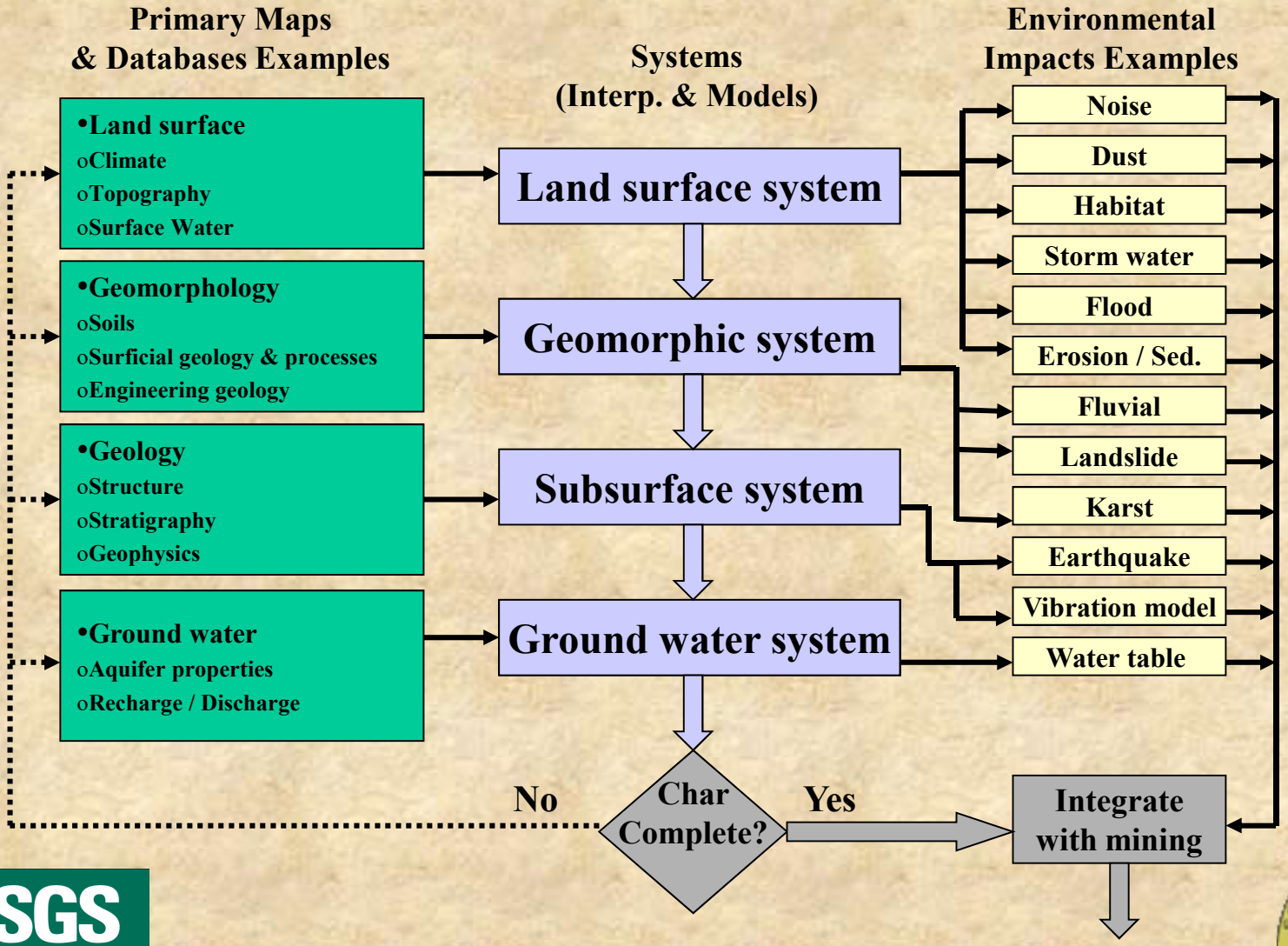
Hierarchical Systems Analysis



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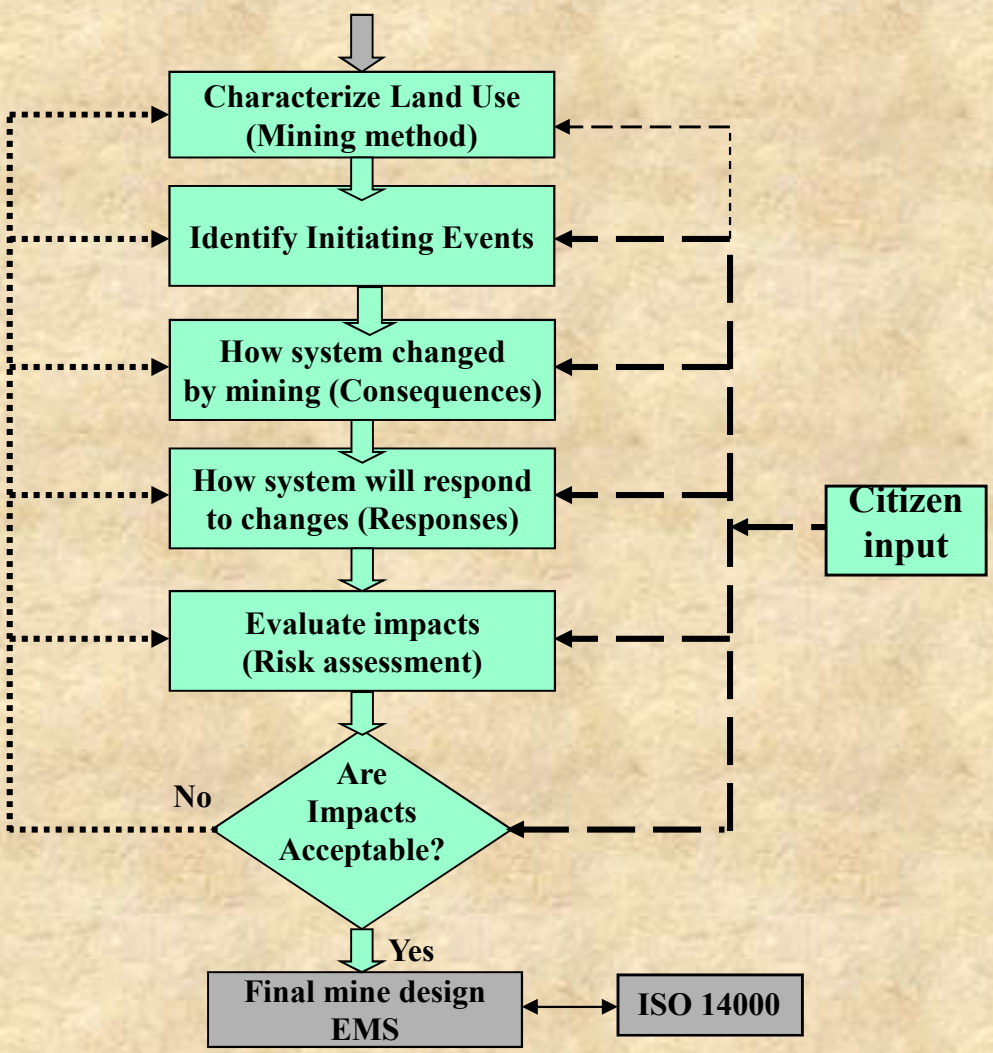
Hierarchical Systems Analysis



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Mining Method

- Quarry or underground mine
- Aggregate or dimension stone

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Uncertainties

- Knowledge
  - Mining involves development in only partially defined physical, chemical, biological, or human environment.
  - Very little published information about the impacts of extraction of construction materials in karst terrains.
  - Engineering / geologic state-of-the-art.
- Predictability
  - Environmental damage often occurs far from the point of impact.
  - Most of the hydrologic processes operate underground.
  - Some natural phenomenon are unpredictable.
- Change
  - The natural system is in a state of change due to natural and human activity.
- Performance – People make mistakes.

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Uncertainties => Environmental Risks

Risk commonly is expressed in terms of ***consequences*** and the ***likelihood*** of the consequences being realized.

Initiating events make risks become consequences.

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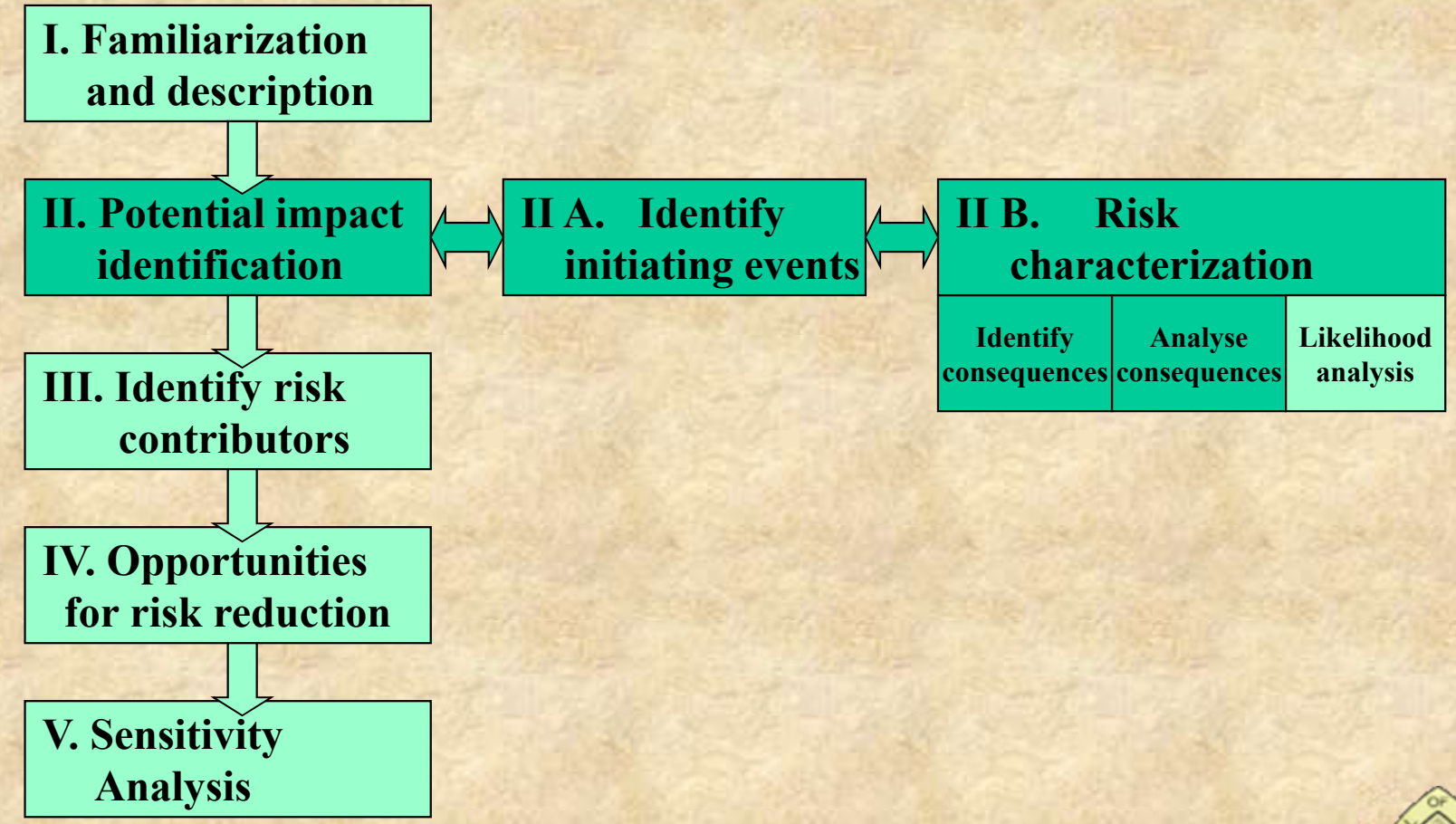
Environmental Risk Assessment

(Borrow from process)



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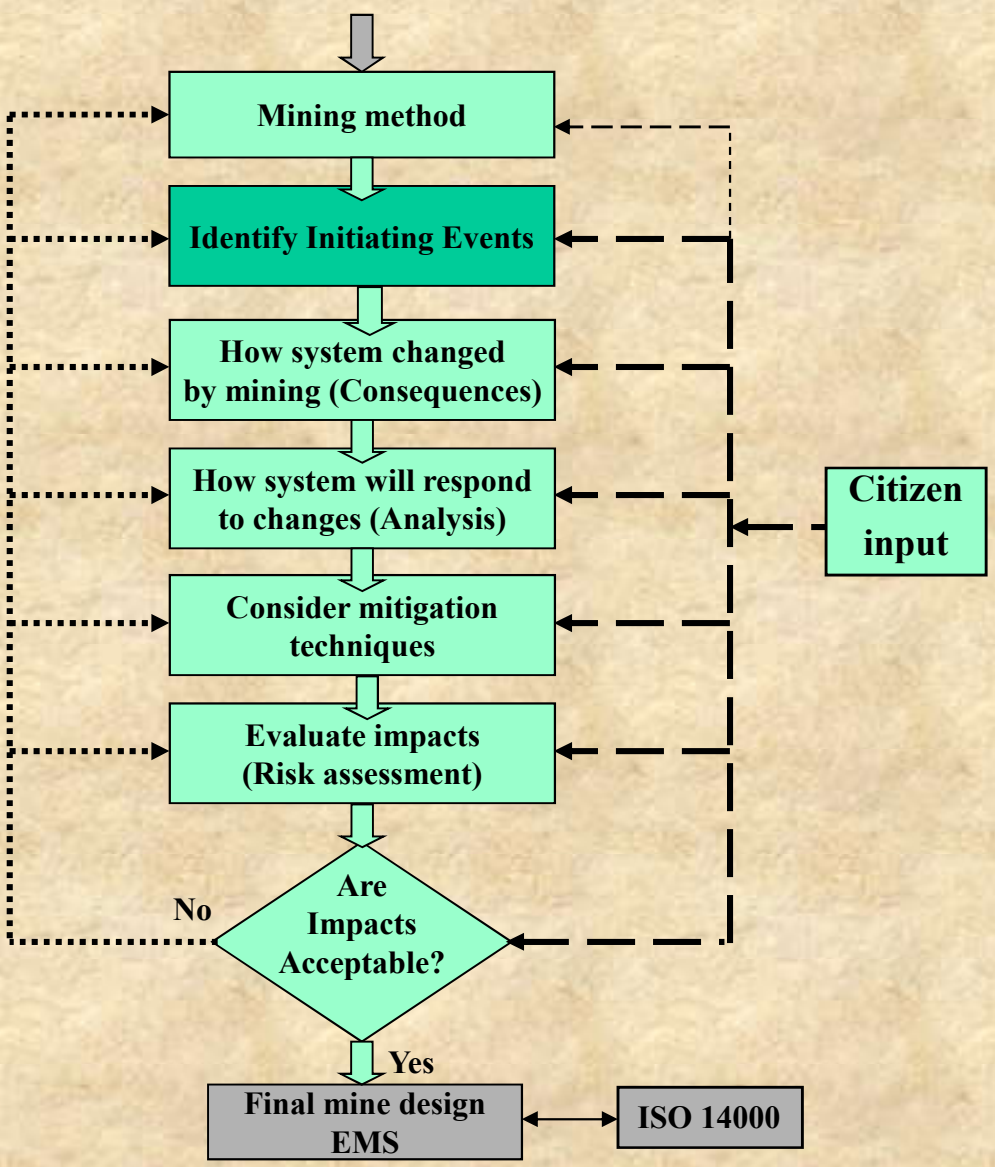
Hierarchical Systems Analysis



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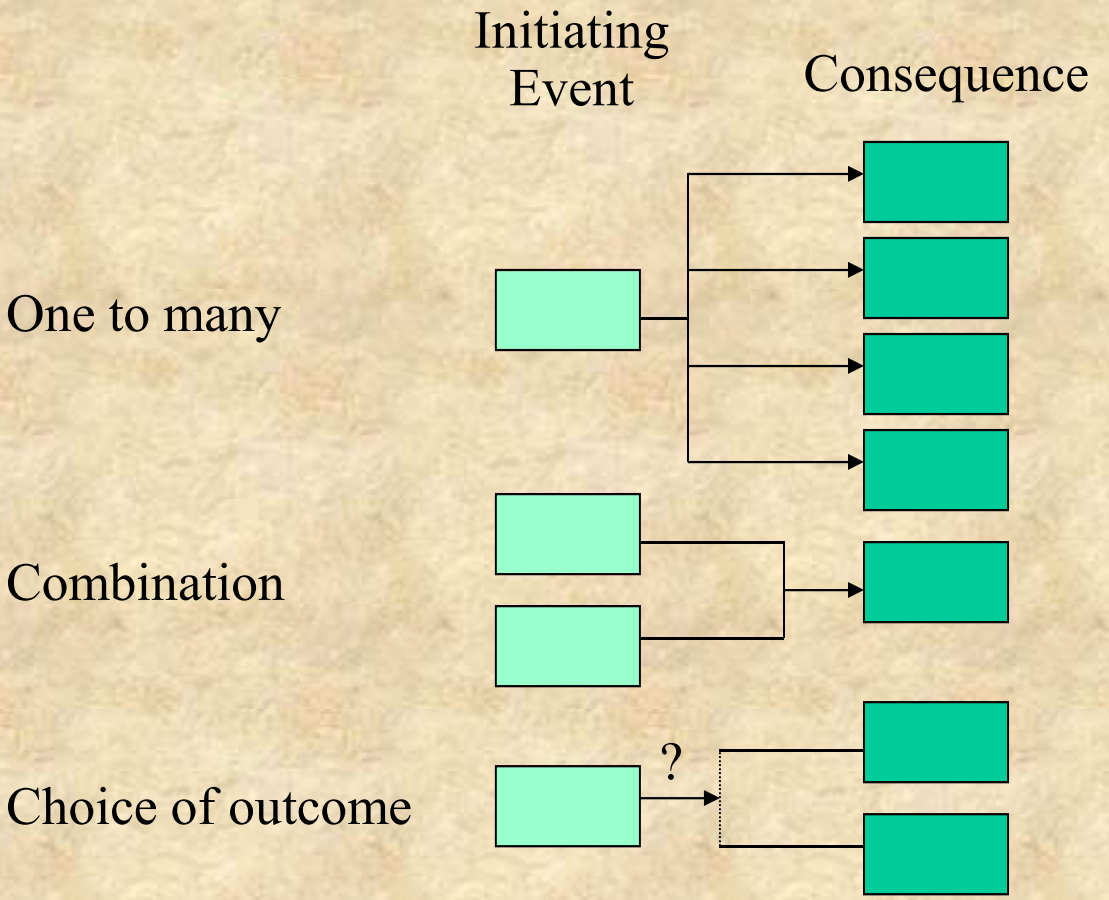
Initiating Events



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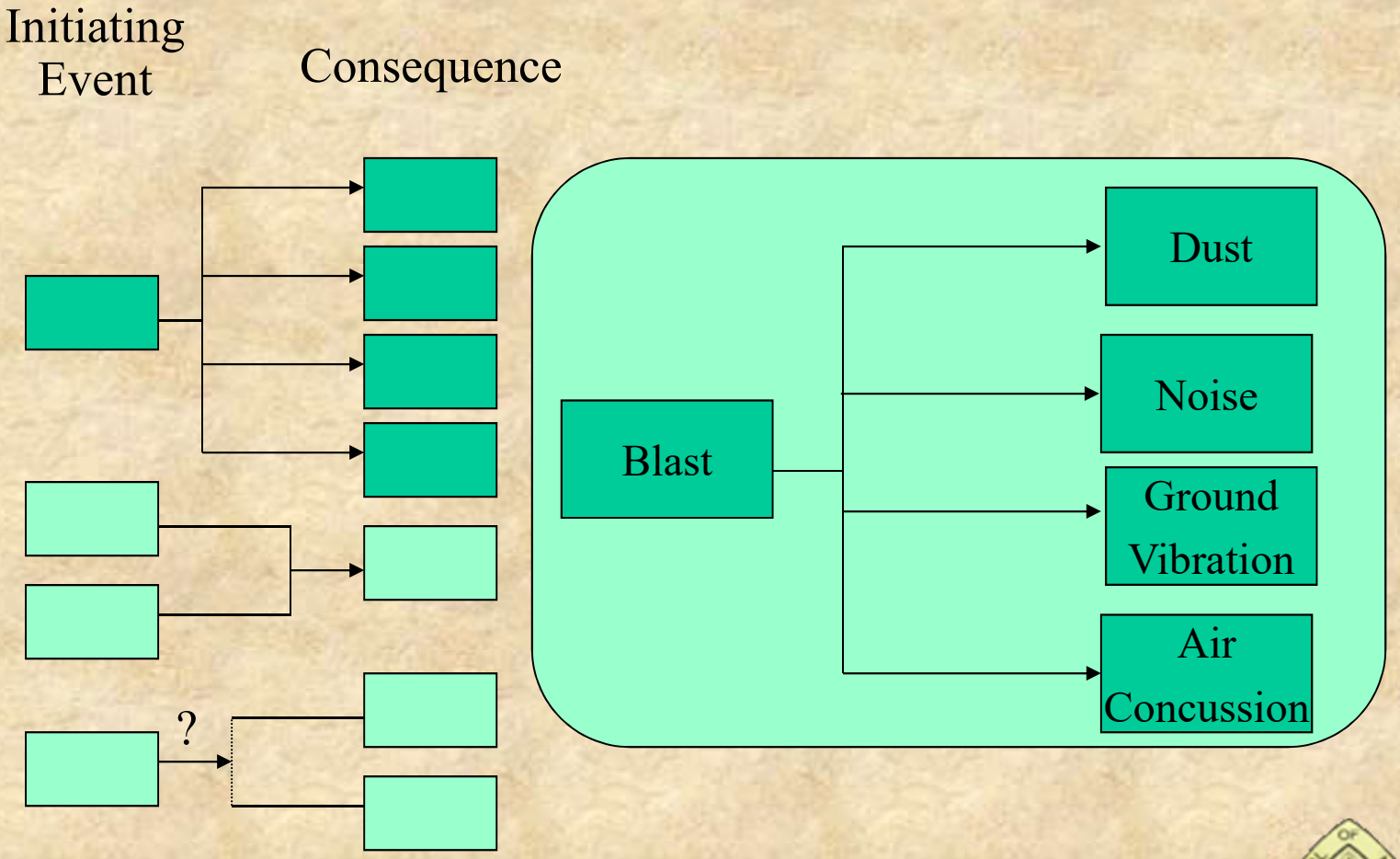
Initiating Events

One to Many



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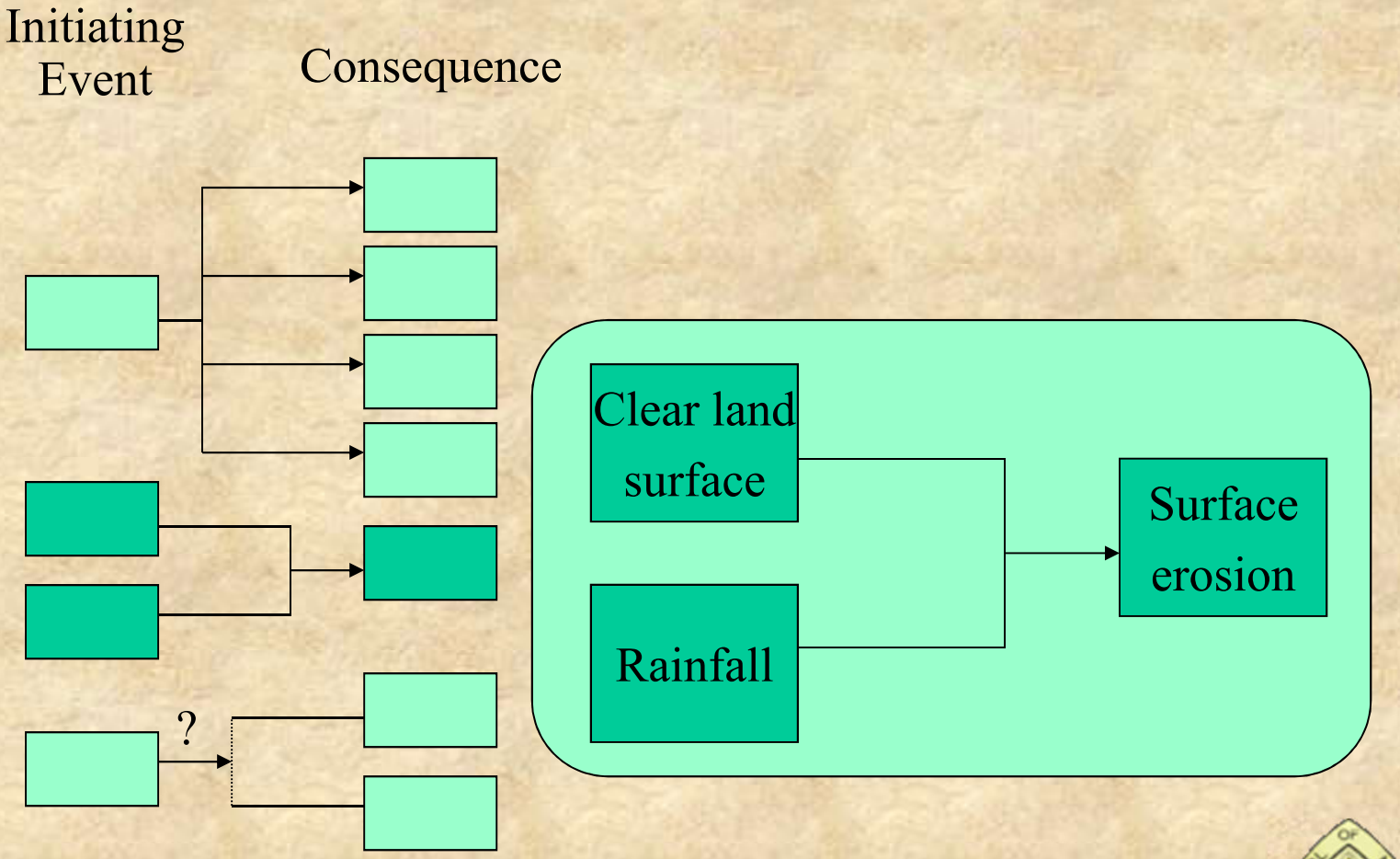
Initiating Events

Combination



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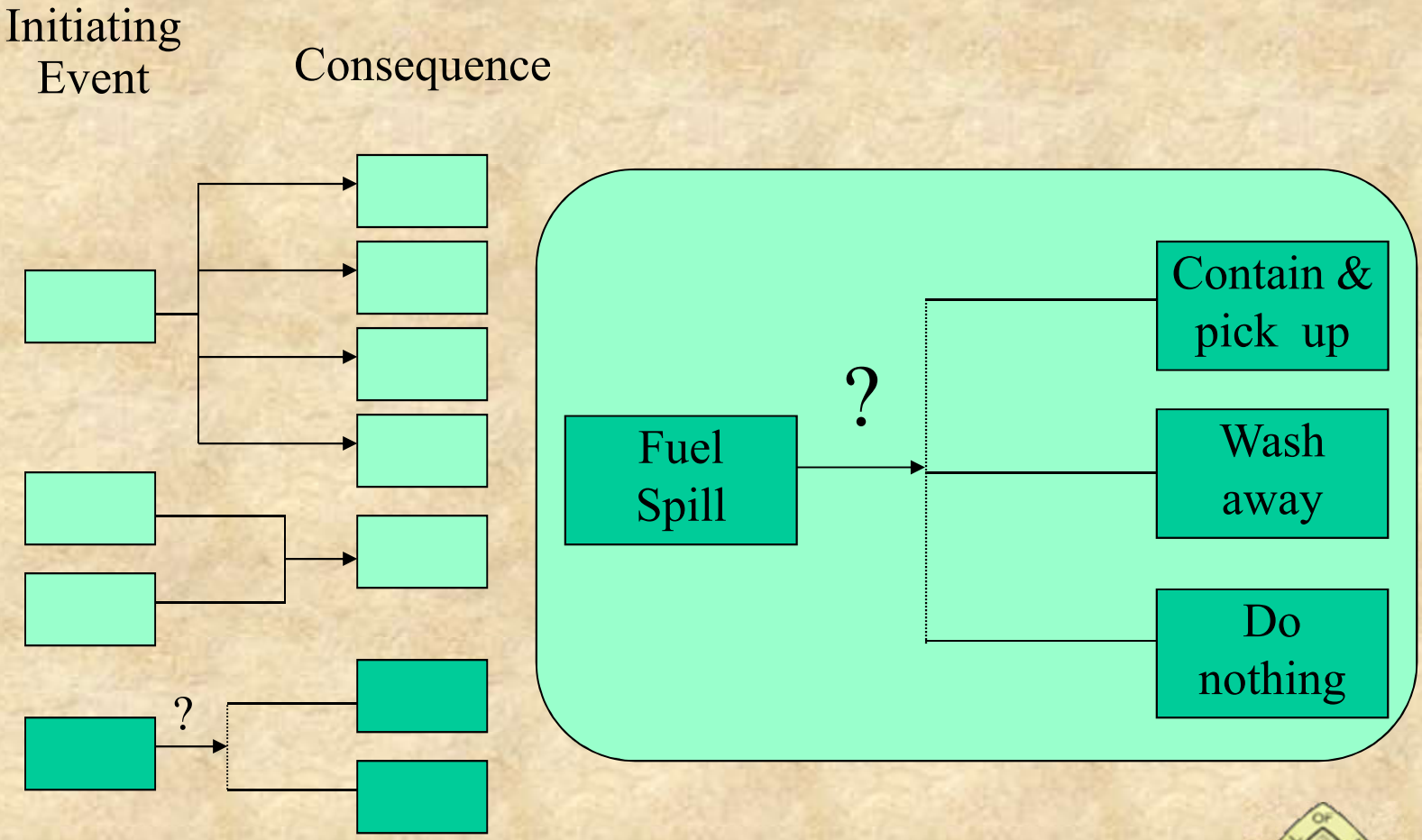
Initiating Events

Choice of Outcome



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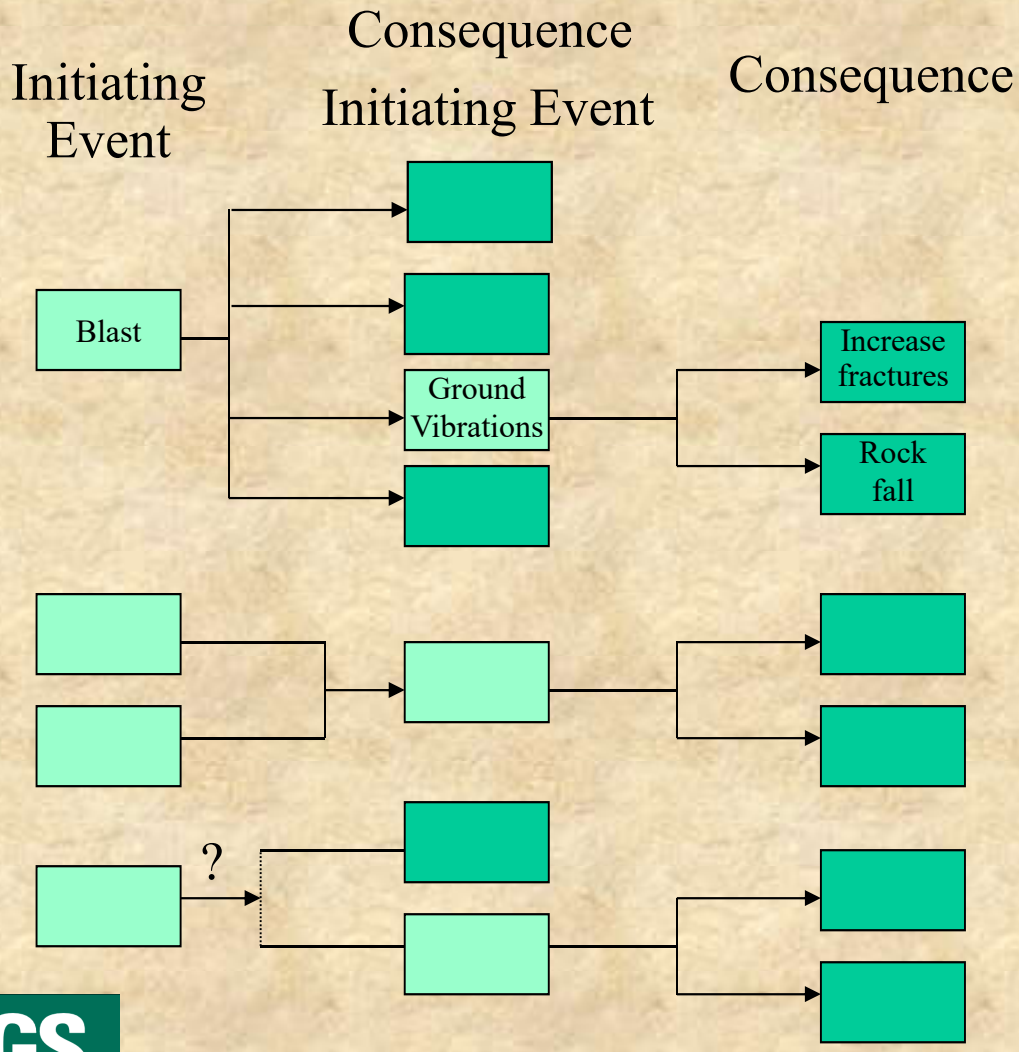
Cascading Initiating Events



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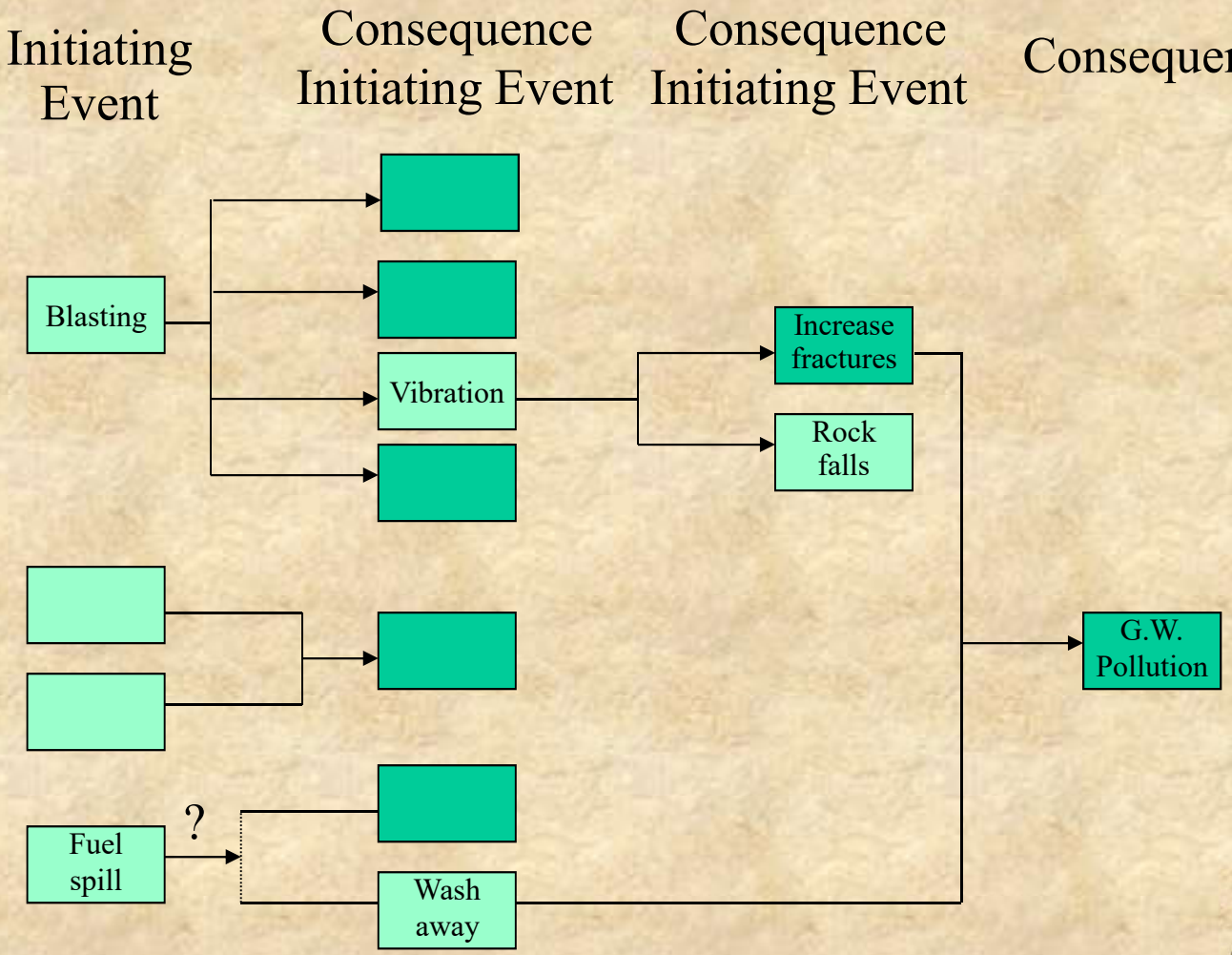
Cascading Initiating Events



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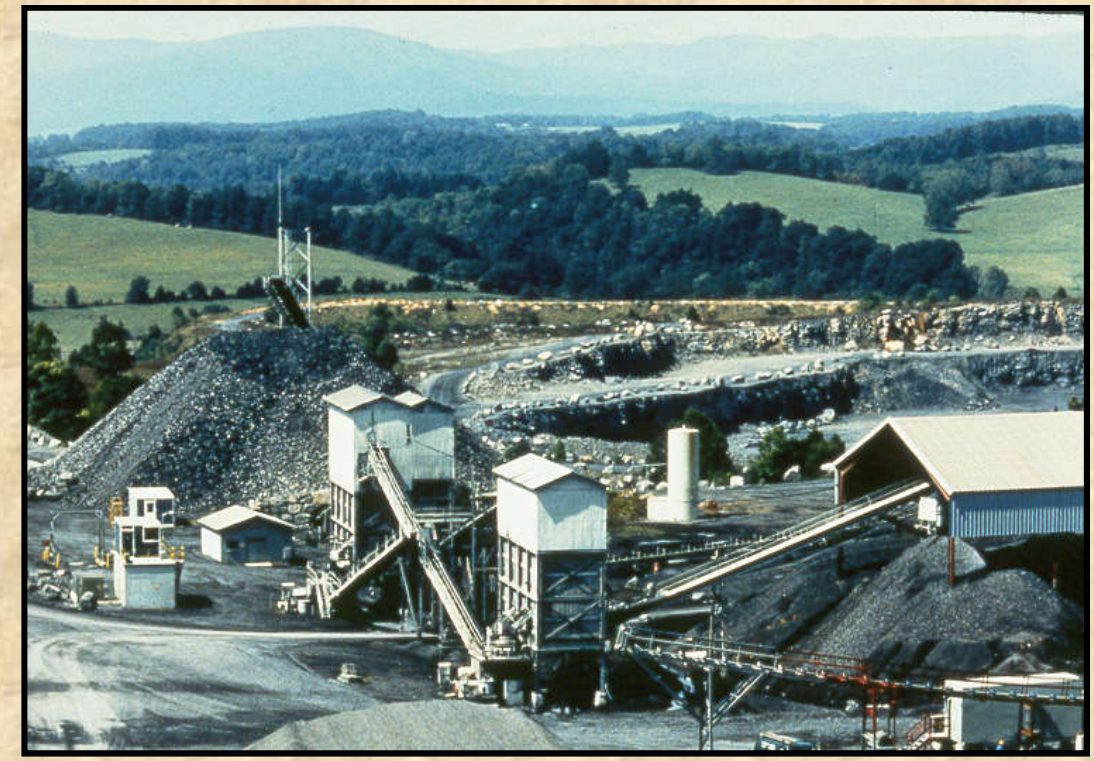
Initiating Events - Examples



Human

- Mining
  - Drilling
  - Blasting
  - Excavating
  - Dewatering
  - In-pit transportation
  - Fuel spills
- Processing
  - Crushing
  - Screening
  - Washing
  - Stockpiling
- Transportation to market
- Reclamation

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Initiating Events - Examples

Natural

- Climate / weather
  - Droughts
  - Heavy rain events
  - Precipitation during critical periods
- Ground-water level changes
- Thresholds
  - River downcutting
- Karstification
- Tectonics

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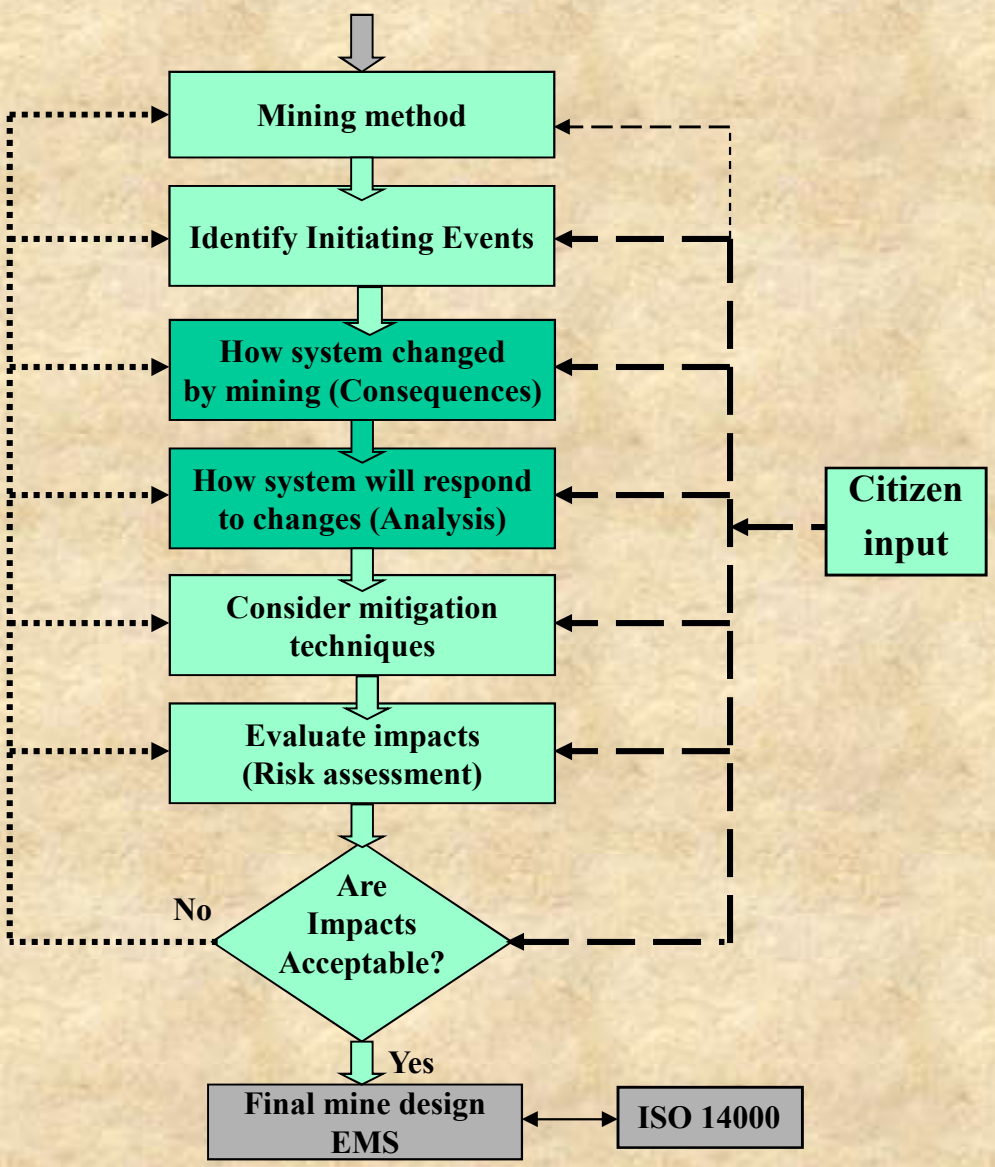
Hierarchical Systems Analysis



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Consequence Analysis

- Consequences can be analyzed and expressed in quantitative or qualitative terms including:
  - Timing of the impact
  - Duration of the impact
  - Range of the impact
  - Magnitude of the impact.

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Potential Consequences – Example

One of Many Possible Outcomes

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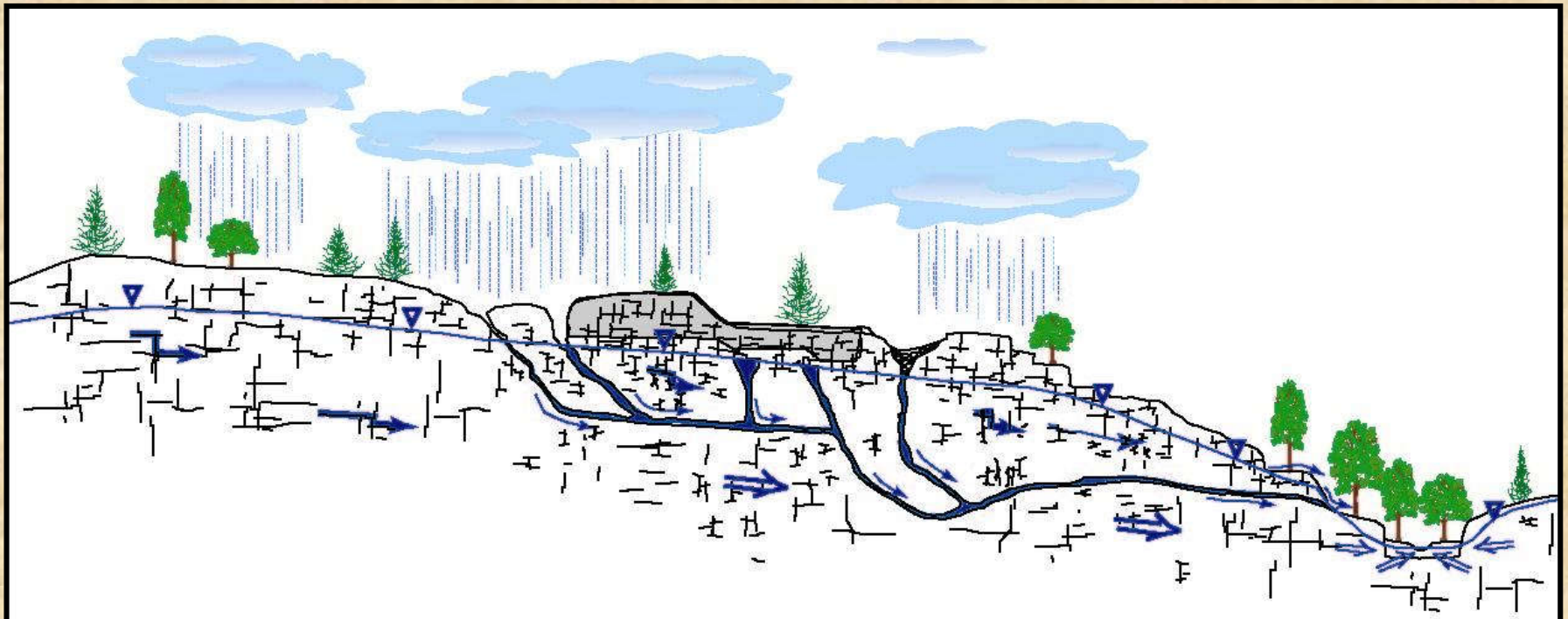
Potential Consequences – Example

Excavation In Unsaturated Zone



Quarrying in the unsaturated zone in karst terrain is likely to result in *relatively local impacts .*

One of Many Possible Outcomes

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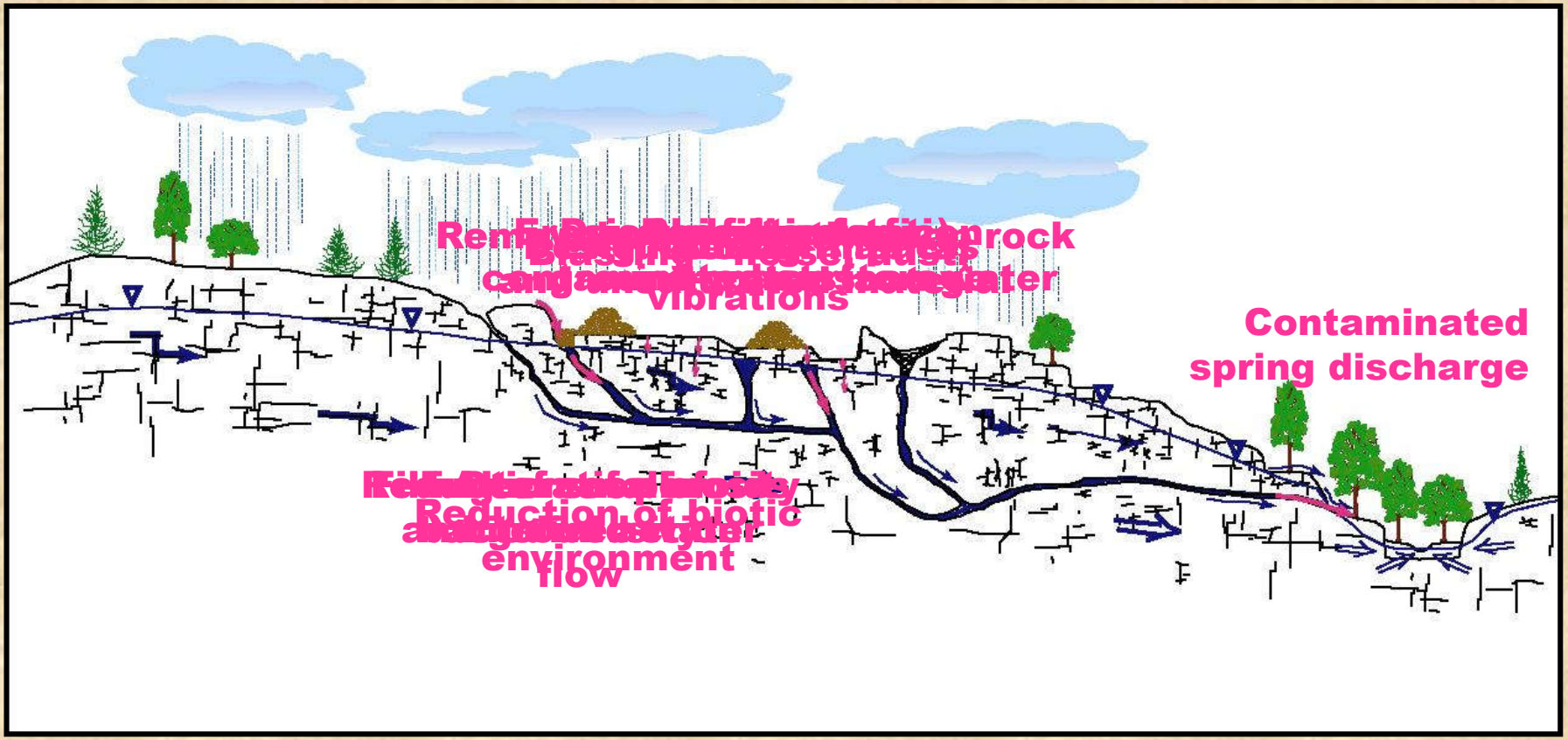
Potential Consequences – Example

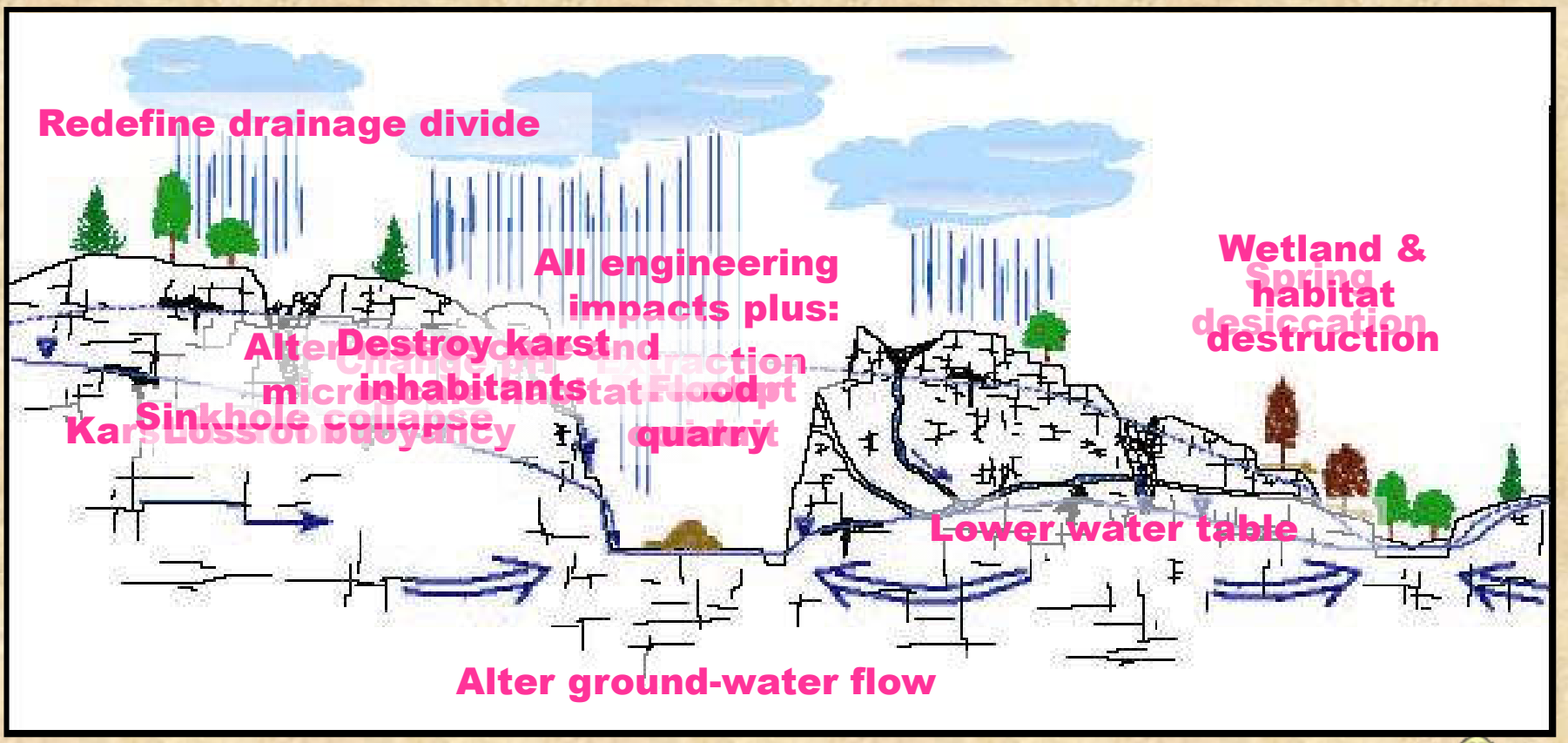
Excavation In Unsaturated Zone



One of Many Possible Outcomes

Potential Consequences – Example

Shallow Excavation In Saturated Zone



One of Many Possible Outcomes

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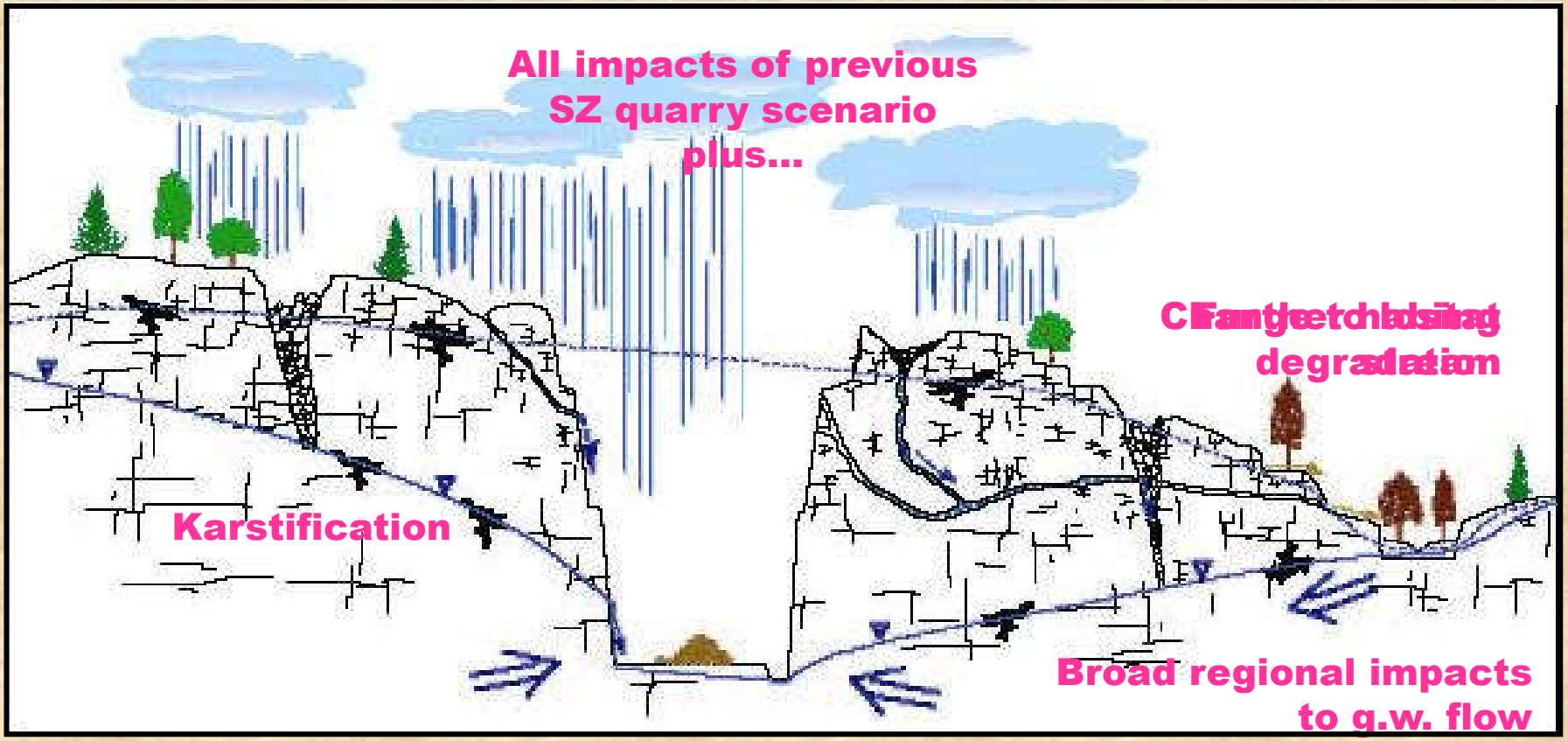
Potential Consequences – Example

Deep Excavation In Saturated Zone



One of Many Possible Outcomes

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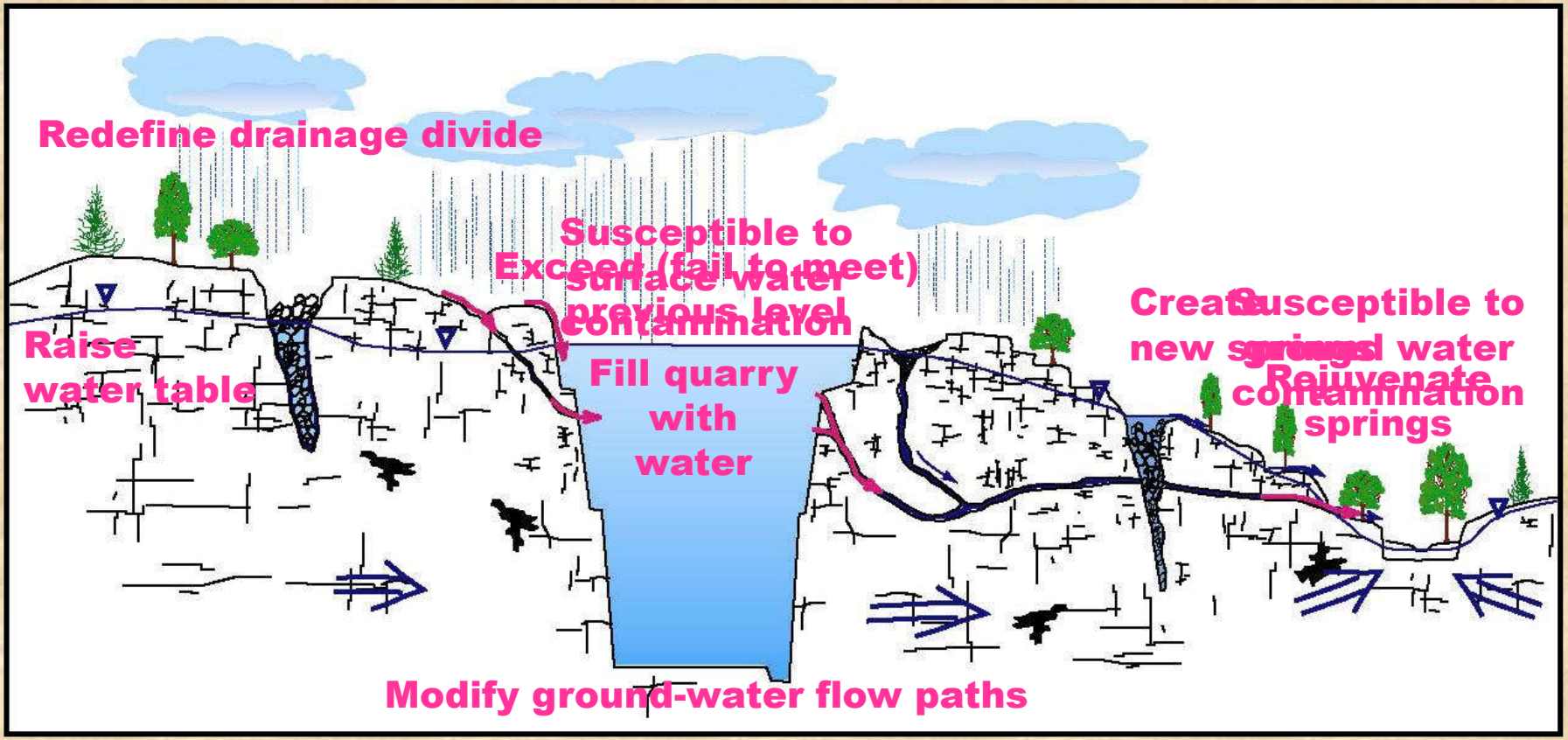
Potential Consequences – Example

Deep Excavation In Saturated Zone - Reclamation



One of Many Possible Outcomes

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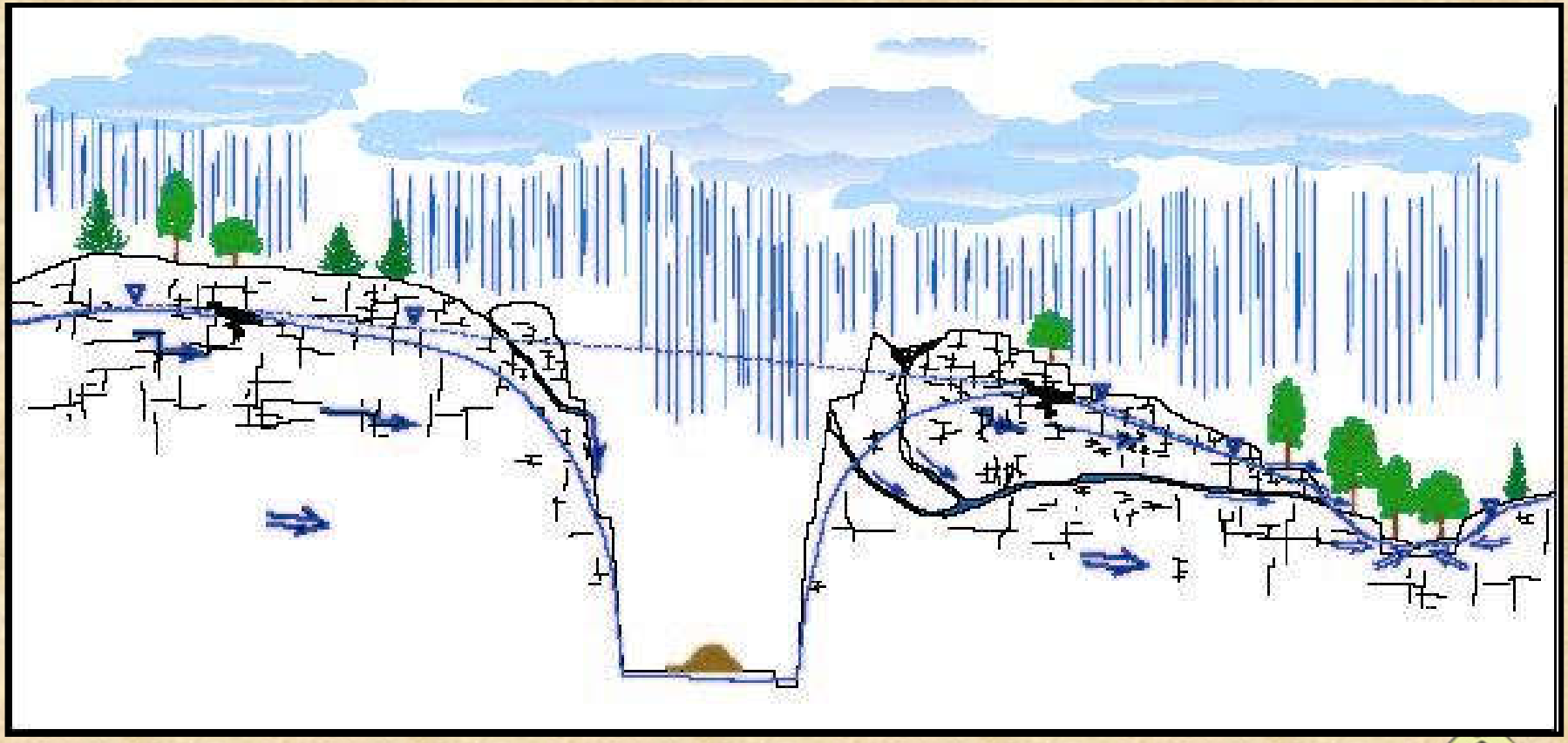
Potential Consequences – Example

Deep Excavation In Saturated Zone
Different Climate or Conductivity



Another Possible Outcome

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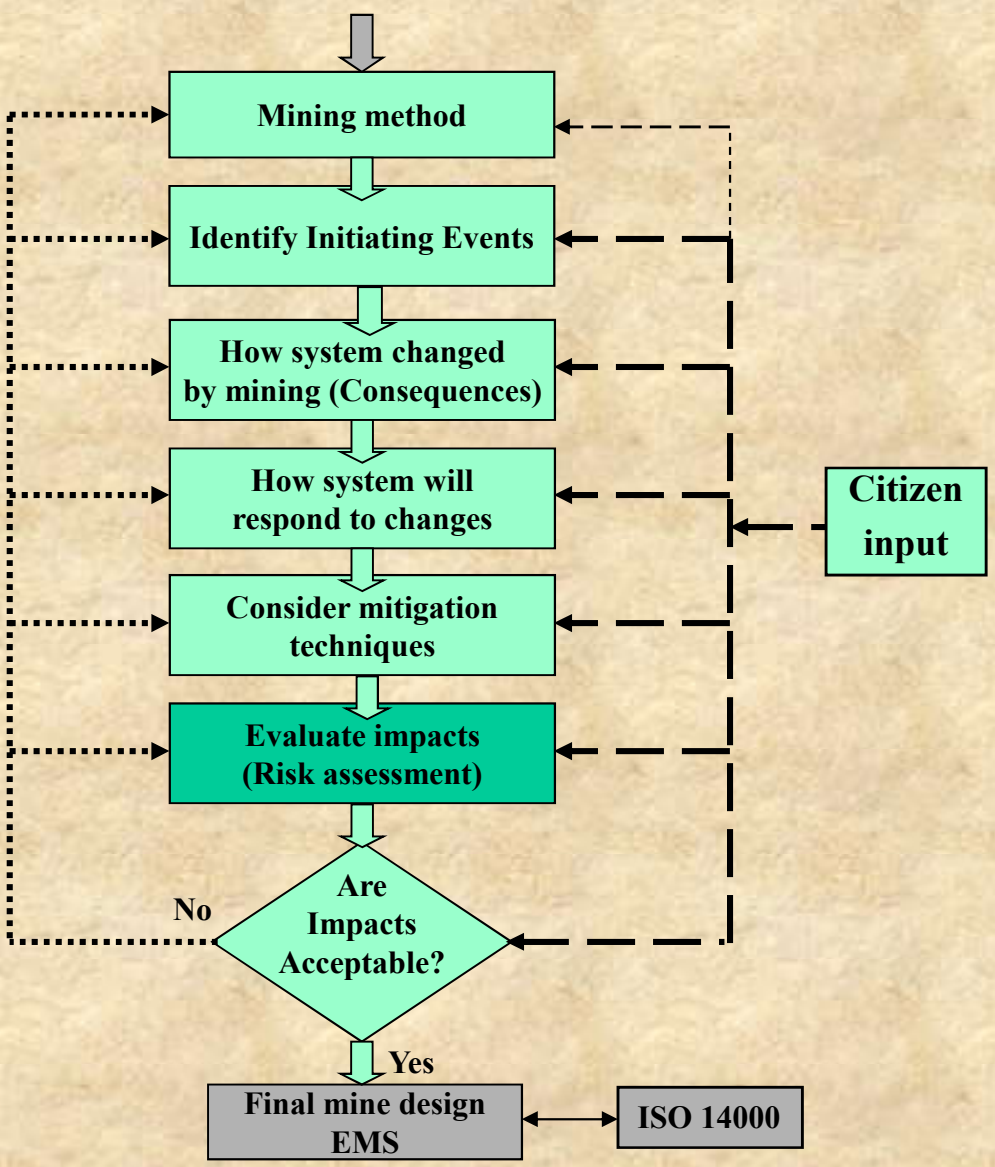
Hierarchical Systems Analysis



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Summary

- We use large amounts of carbonate rocks.
- There is no substitute material for the majority of uses.
- We need to continue to mine carbonate rocks.
- Aggregate mining will create **environmental impacts**.

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Summary

- Numerous possible impacts
- Cascading impacts
- Numerous possible outcomes
- Dependent on natural and human conditions.

GOAL: Provide a continuing supply of high quality carbonate rocks while sustaining environmental quality.

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Hierarchical Systems Analysis

One method to accomplish this goal.