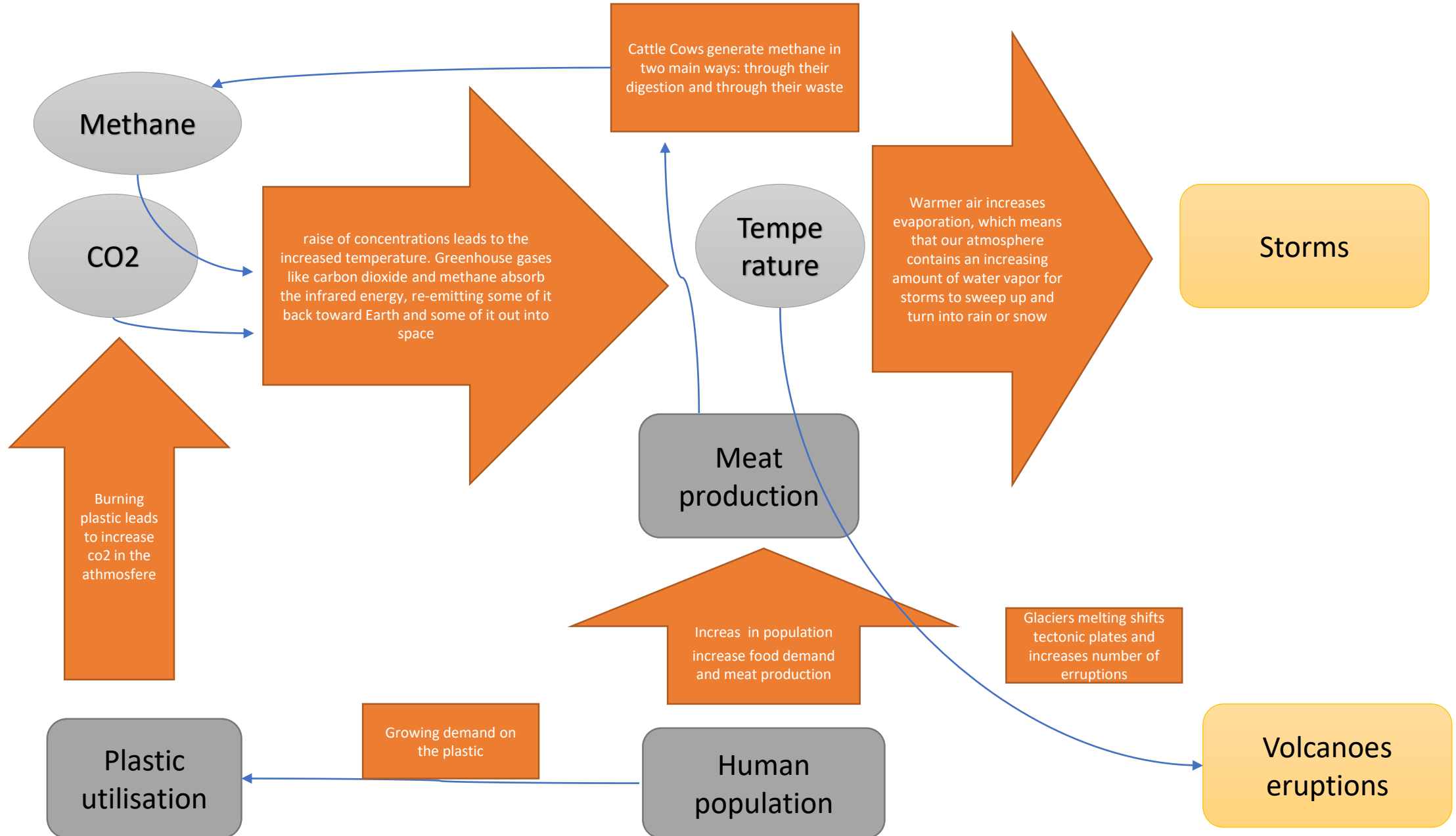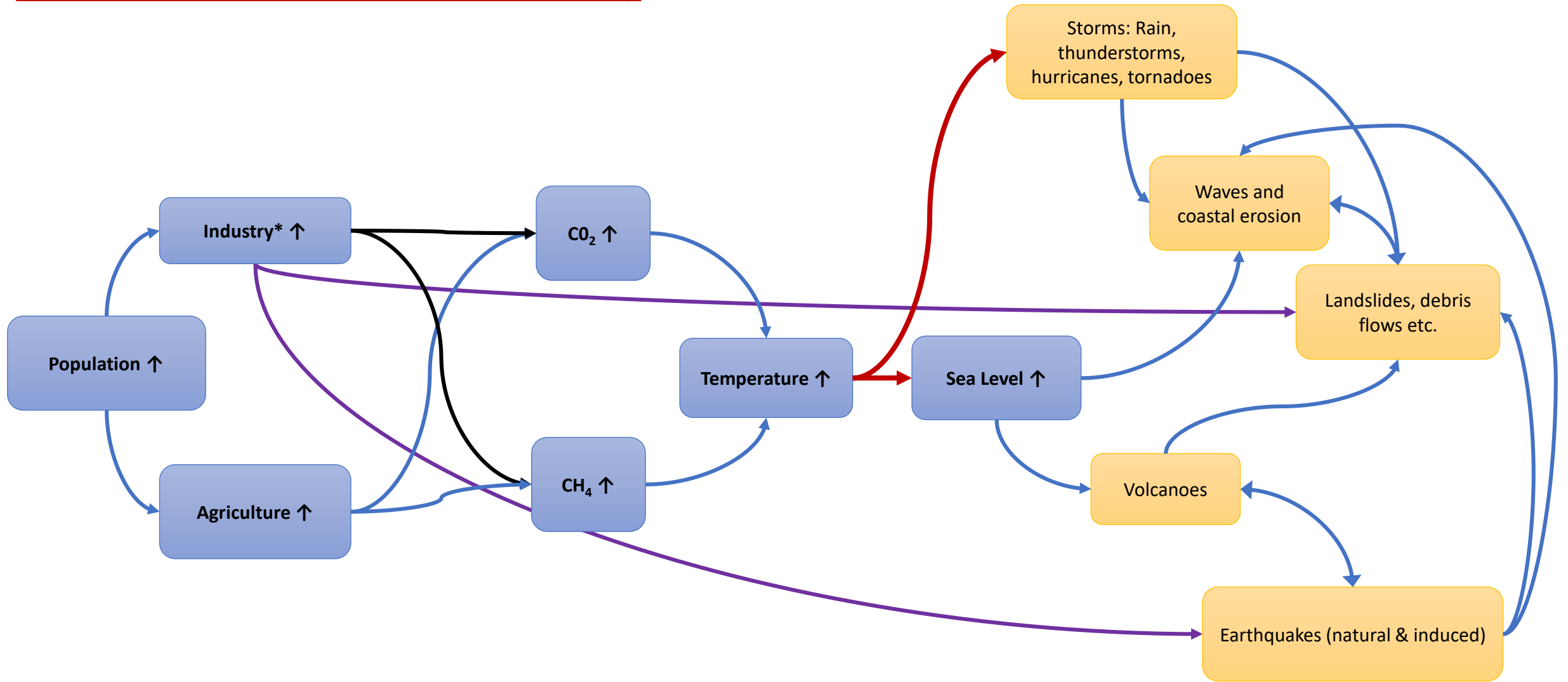# A Natural Hazards "cause and effect" activity

- Driving questions:
  - *"In what ways can climate change increase the severity and/or frequency of ~~natural hazards~~ earthquakes?"*
  - *"Does this hazard affect global climate?"*

- Mind maps serve to describe relationships between causes and effects.

- Slides 2 and 3 are examples of mind-mapping this issue.

- We discover that most "causes" are in fact a sequence of cause-and-effect relationships.

A preliminary expression of the idea

Methane

CO2

Cattle Cows generate methane in two main ways: through their digestion and through their waste

raise of concentrations leads to the increased temperature. Greenhouse gases like carbon dioxide and methane absorb the infrared energy, re-emitting some of it back toward Earth and some of it out into space

Tempe rature

Warmer air increases evaporation, which means that our atmosphere contains an increasing amount of water vapor for storms to sweep up and turn into rain or snow

Storms

Burning plastic leads to increase co2 in the athmosfere

Meat production

Increas in population increase food demand and meat production

Glaciers melting shifts tectonic plates and increases number of erruptions

Plastic utilisation

Growing demand on the plastic

Human population

Volcanoes eruptions

FJ's attempt at a more "complete" mind map

Population ↑

Industry* ↑

Agriculture ↑

CO_2 ↑

CH_4 ↑

Temperature ↑

Sea Level ↑

Storms: Rain, thunderstorms, hurricanes, tornadoes

Waves and coastal erosion

Landslides, debris flows etc.

Volcanoes

Earthquakes (natural & induced)

Could induce any or ALL 5 other hazards depending on size and location.
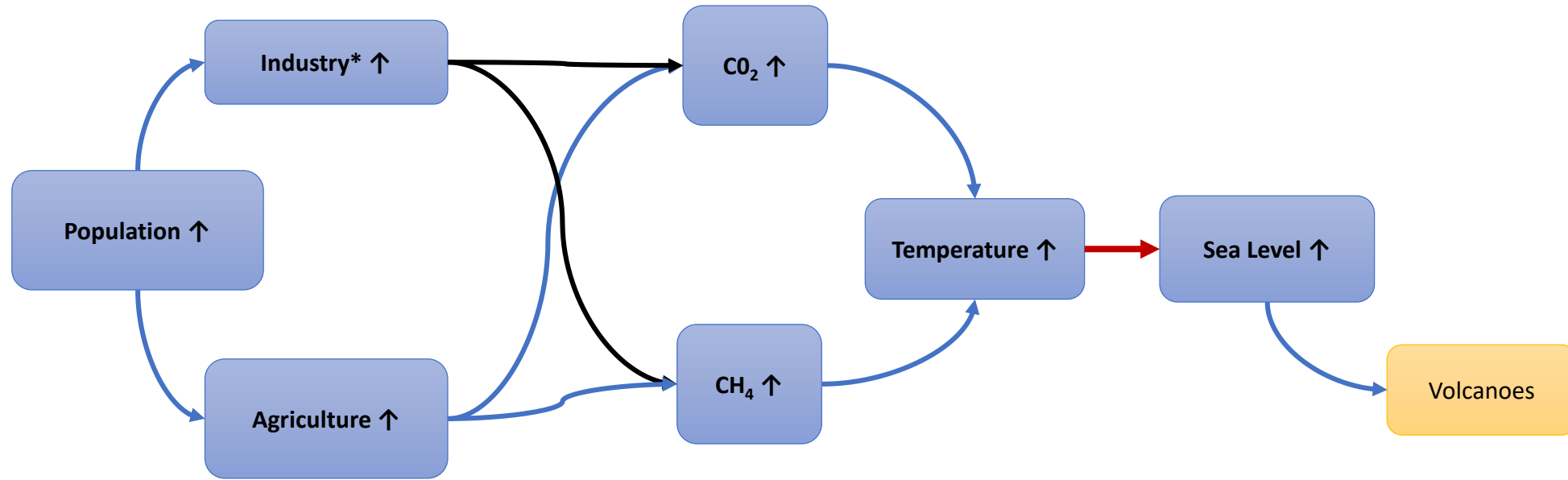
Impact from space

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

"Natural" hazards not in eosc114: floods, fires, pestilence, biodiversity decline, drought, etc.

FJ's attempt at a more "complete" mind map

Demand for food, burning fuel for transport and production, removal of waste (plastics especially)

Burning fuel and production processes produces both

Increased moisture and thermal capacity

Increased severity and frequency of rainfall; tsunami from landslides

Increase in atmospheric concentration of both CO_2 and CH_4 causes warmer air at all levels

Storms: Rain, thunderstorms, hurricanes, tornadoes

Tsunami

Industry* ↑

CO_2 ↑

Population ↑

Bad land-use practices (eg. forestry roads, etc.)

Waves and coastal erosion

Increased severity and frequency

Landslides, debris flows etc.

Temperature ↑

Sea Level ↑

Lahars, etc.

Shaking

CH_4 ↑

Melting ice caps

Volcanoes

Shaking & fluid motions

Agriculture ↑

Shifting tectonics

Clearing land, mechanized production

Producing meat

Ground water, CO2 injection, fracking, etc.

Earthquakes (natural & induced)

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

Could induce any or ALL 5 other hazards depending on size and location.

Impact from space

"Natural" hazards not in eosc114: floods, fires, pestilence, biodiversity decline, drought, etc.

FJ's attempt at a more "complete" mind map

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

"Natural" hazards not in eosc114: floods, fires, pestilence, biodiversity decline, drought, etc.

Could induce any or ALL 5 other hazards depending on size and location.
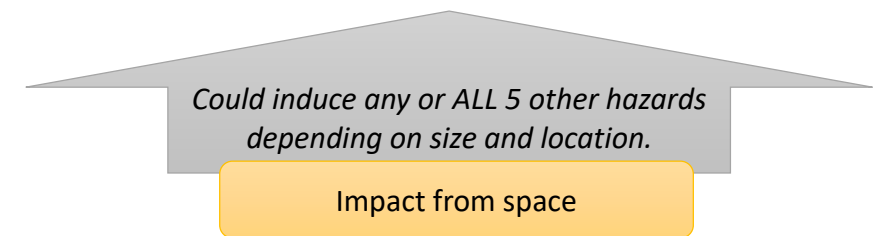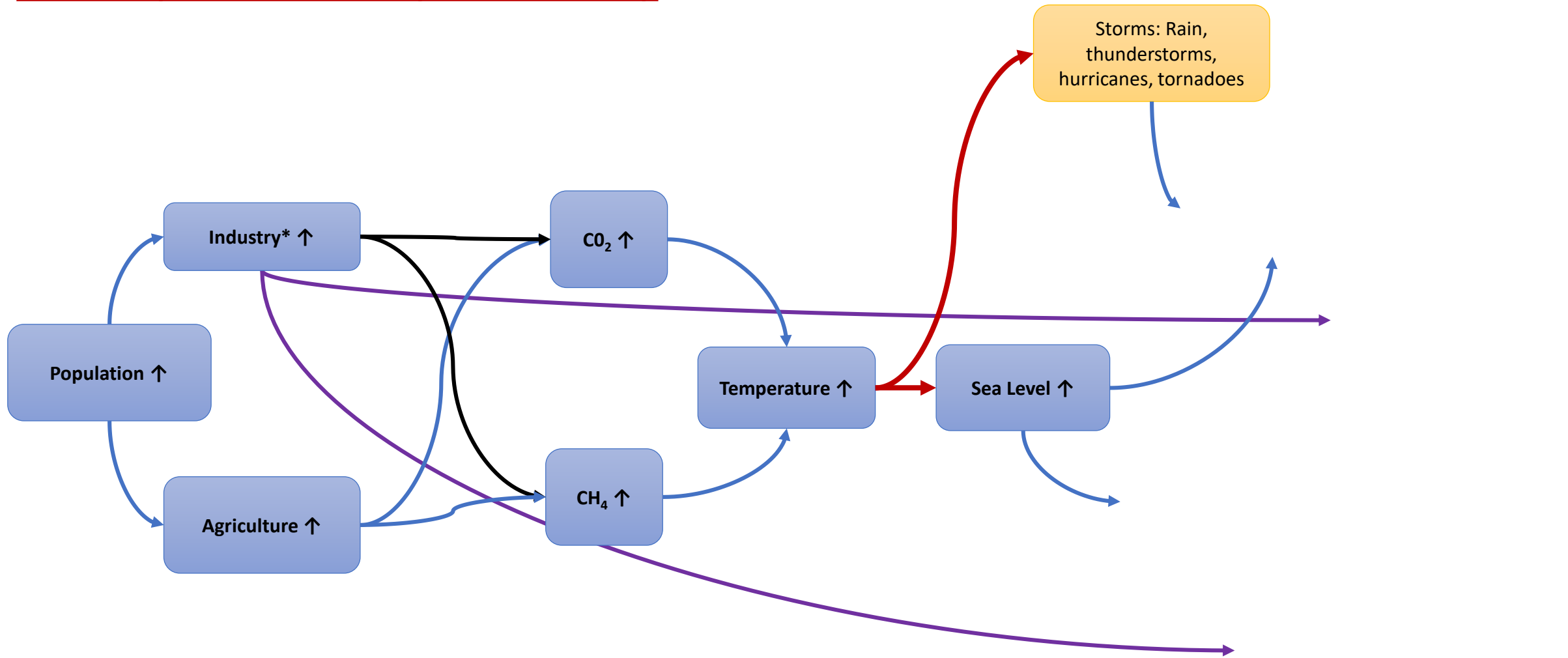
Impact from space

FJ's attempt at a more "complete" mind map

Storms: Rain, thunderstorms, hurricanes, tornadoes

Industry* ↑

CO_2 ↑

Population ↑

Temperature ↑

Sea Level ↑

Agriculture ↑

CH_4 ↑

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

"Natural" hazards not in eosc114: floods, fires, pestilence, biodiversity decline, drought, etc.

Could induce any or ALL 5 other hazards depending on size and location.

Impact from space

An alternative approach for a "cause and effect" assignment

- Mind mapping is great, but very "open ended". It could get quite complex and will be challenging for students when not done more than once. E.g. students may have trouble deciding what's "good enough". Mind maps are also "costly" to assess.

- The following slide sequence outlines a five-part activity.

- Something like this might be programmable as an interactive online app or "dashboard", with a sequence of steps

- Students would move boxes around with their mouse, as between slides #5 and #6.

- Text boxes would be provided to write relationships as in Slide #8 other others.

- Students would draw straight lines for part IV, and enter short text explanations.

- Their results, such as slides #8 and #19, can be saved as an image and submitted for assessment, either with a rubric or on a scale of   *0=inadequate/not done;   1=done but poorly;   2=good enough*.

- The whole thing could be concluded with an online quiz.

- This is just an idea. Probably lots of room to improve. I'm still a bit unhappy with slides 10-14 because it feels awkward.

- All this needs discussion.
    - Is it meeting the aims (learning goals) of the course and the exercise?
    - Is it practical to deploy and practical for students to complete?
    - Will most students be able to get most of the activity right?
    - Is the whole idea awkward or confusing for students?
    - Can reasonably "high level" assessment or test questions be derived (yes, almost certainly)?
    - Other questions you all will no doubt have …

PART I:

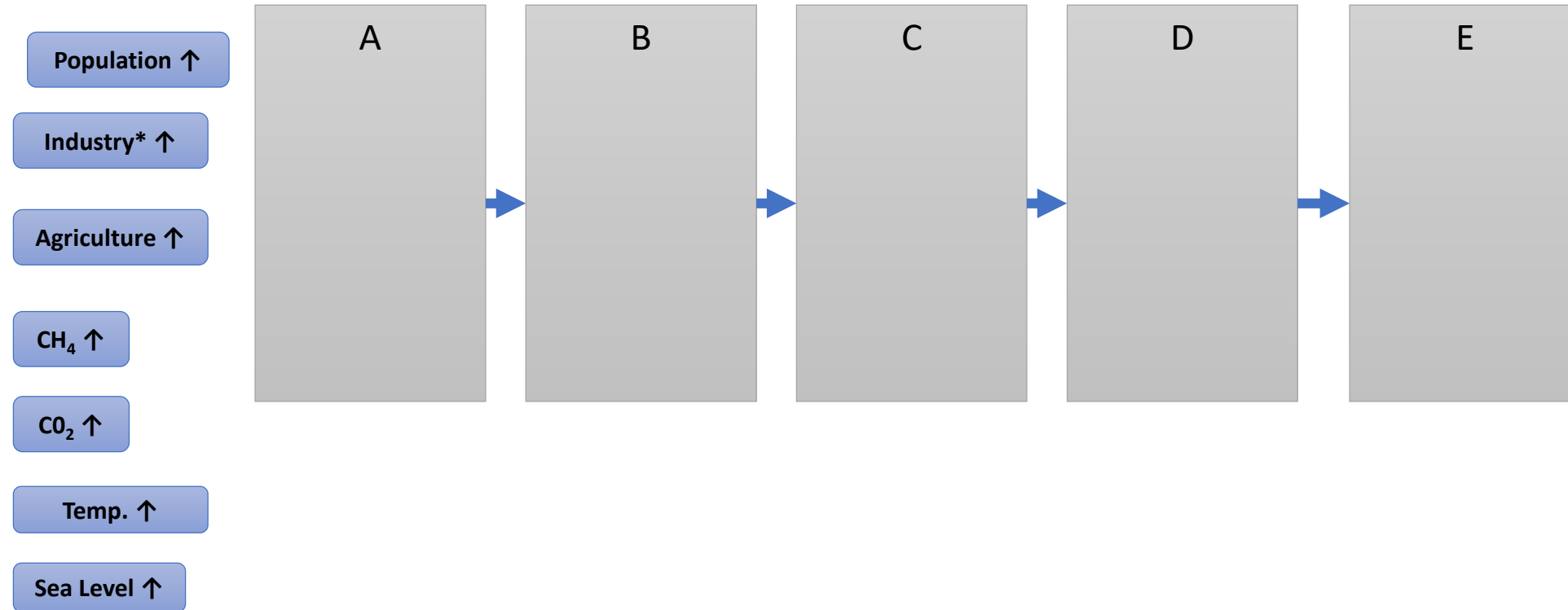Each item in blue indicates a cause due to "increase in …". Place each in either box …

A, a primary case, or in

B caused by one or more in A, or in

C caused by one or more in B, or in

D caused by one or more in C, or in

E caused by one or more in D.

Population ↑	A	B	C	D	E
Industry* ↑					
Agriculture ↑					
CH_4 ↑					
CO_2 ↑					
Temp. ↑					
Sea Level ↑					

* Industry = energy production, transportation,
   materials (plastics, etc.), goods (not food)

PART I: solution

Each item in blue indicates a cause due to "increase in …". Place each in either box …
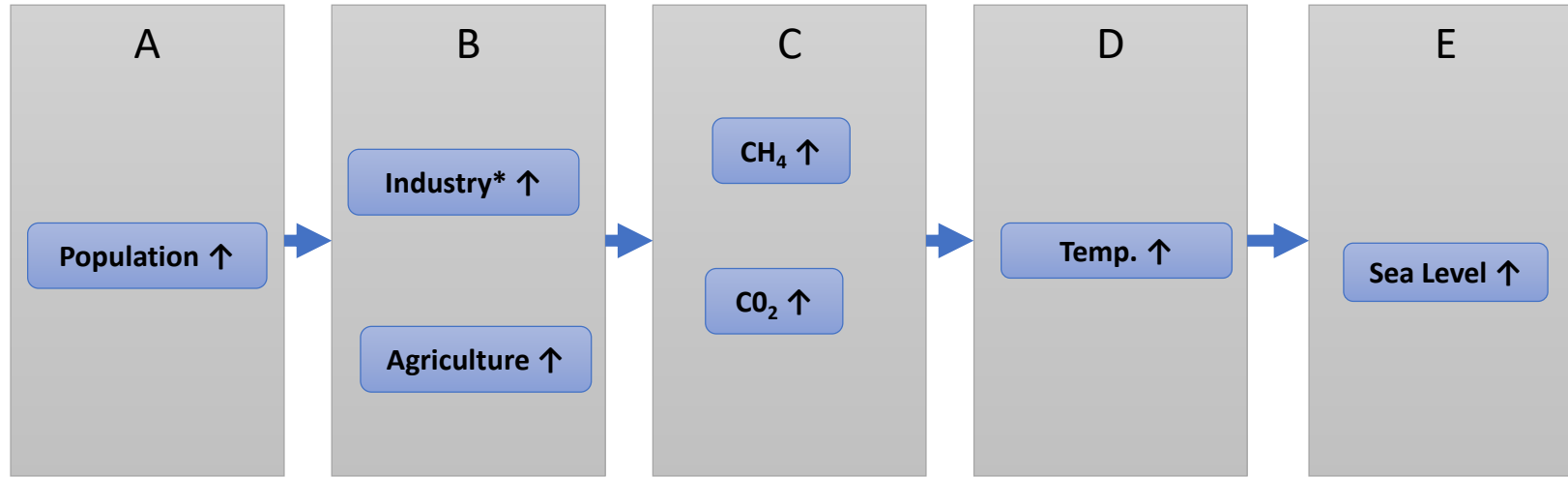A, a primary case, or in
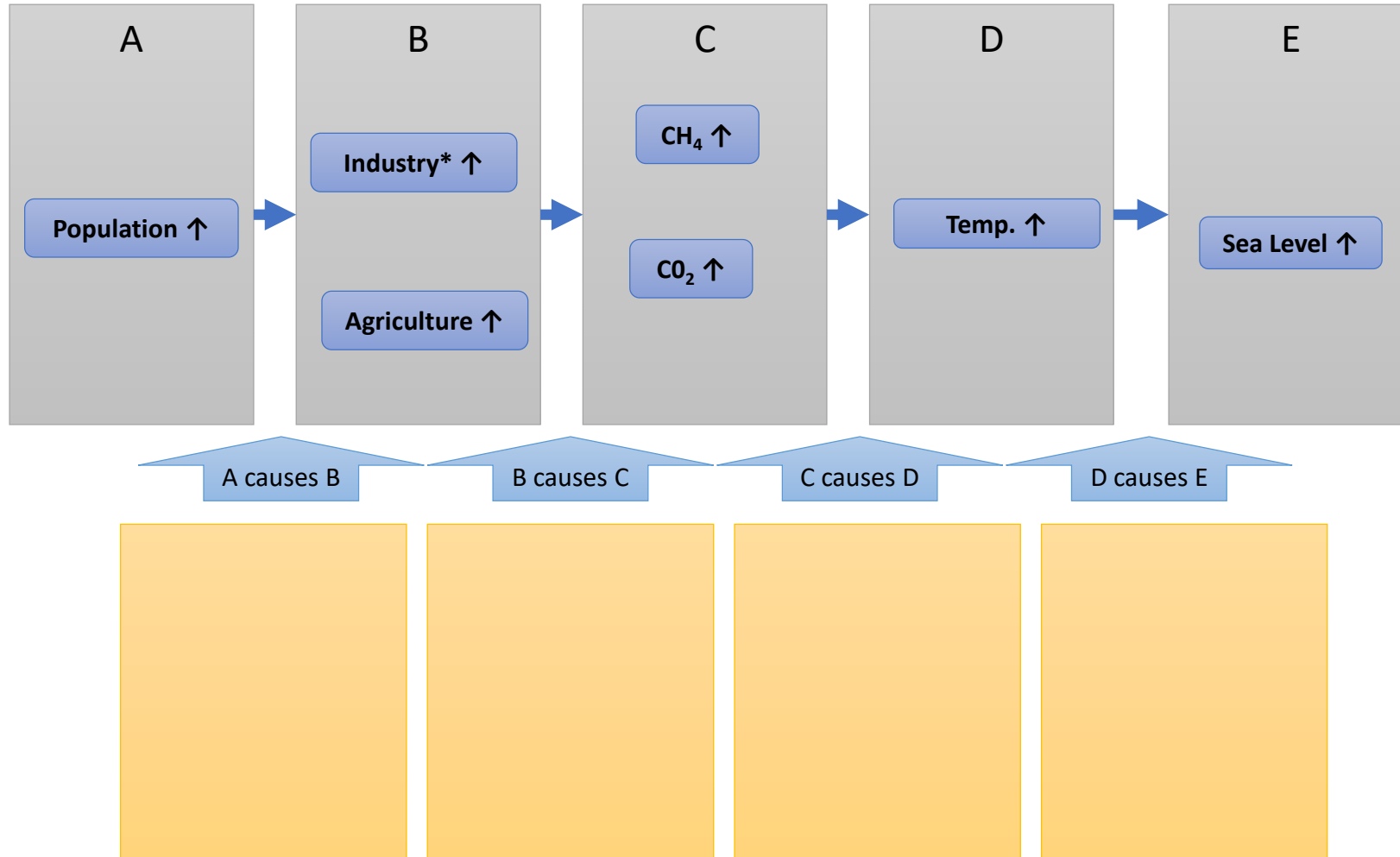B caused by one or more in A, or in
C caused by one or more in B, or in
D caused by one or more in C, or in
E caused by one or more in D.

A	B	C	D	E
Population ↑	Industry* ↑ Agriculture ↑	CH_4 ↑ CO_2 ↑	Temp. ↑	Sea Level ↑

* Industry = energy production, transportation,
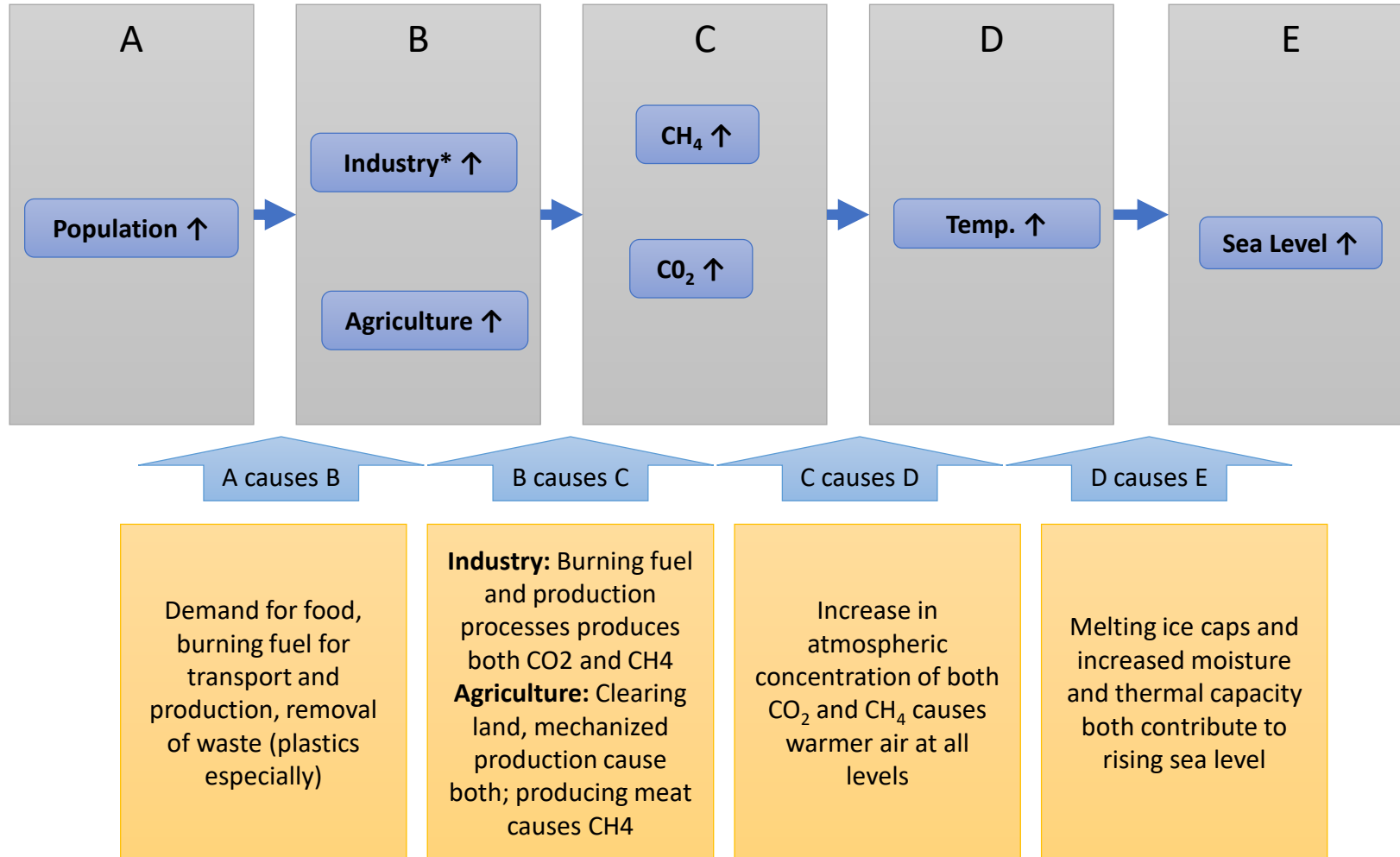   materials (plastics, etc.), goods (not food)

PART II:

Write a few words describing **how** factors in A cause increases in factors in B, how B causes increases in C, and so on.

A	B	C	D	E
Population ↑	Industry* ↑ Agriculture ↑	CH_4 ↑ CO_2 ↑	Temp. ↑	Sea Level ↑

A causes B | B causes C | C causes D | D causes E

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

PART II: solution

Write a few words describing how factors in A cause increases in factors in B, how B causes increases in C, and so on.

A	B	C	D	E
Population ↑	Industry* ↑ Agriculture ↑	CH_4 ↑ CO_2 ↑	Temp. ↑	Sea Level ↑

A causes B	B causes C	C causes D	D causes E
Demand for food, burning fuel for transport and production, removal of waste (plastics especially)	**Industry:** Burning fuel and production processes produces both CO2 and CH4 **Agriculture:** Clearing land, mechanized production cause both; producing meat causes CH4	Increase in atmospheric concentration of both CO_2 and CH_4 causes warmer air at all levels	Melting ice caps and increased moisture and thermal capacity both contribute to rising sea level

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

PART III:
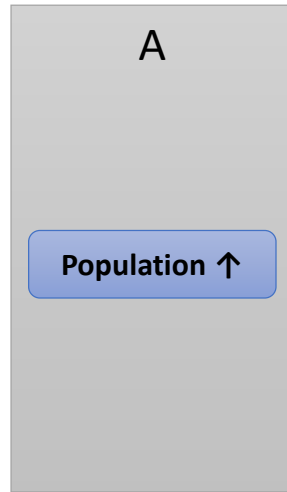Now consider how increases in these factors could affect natural hazards.
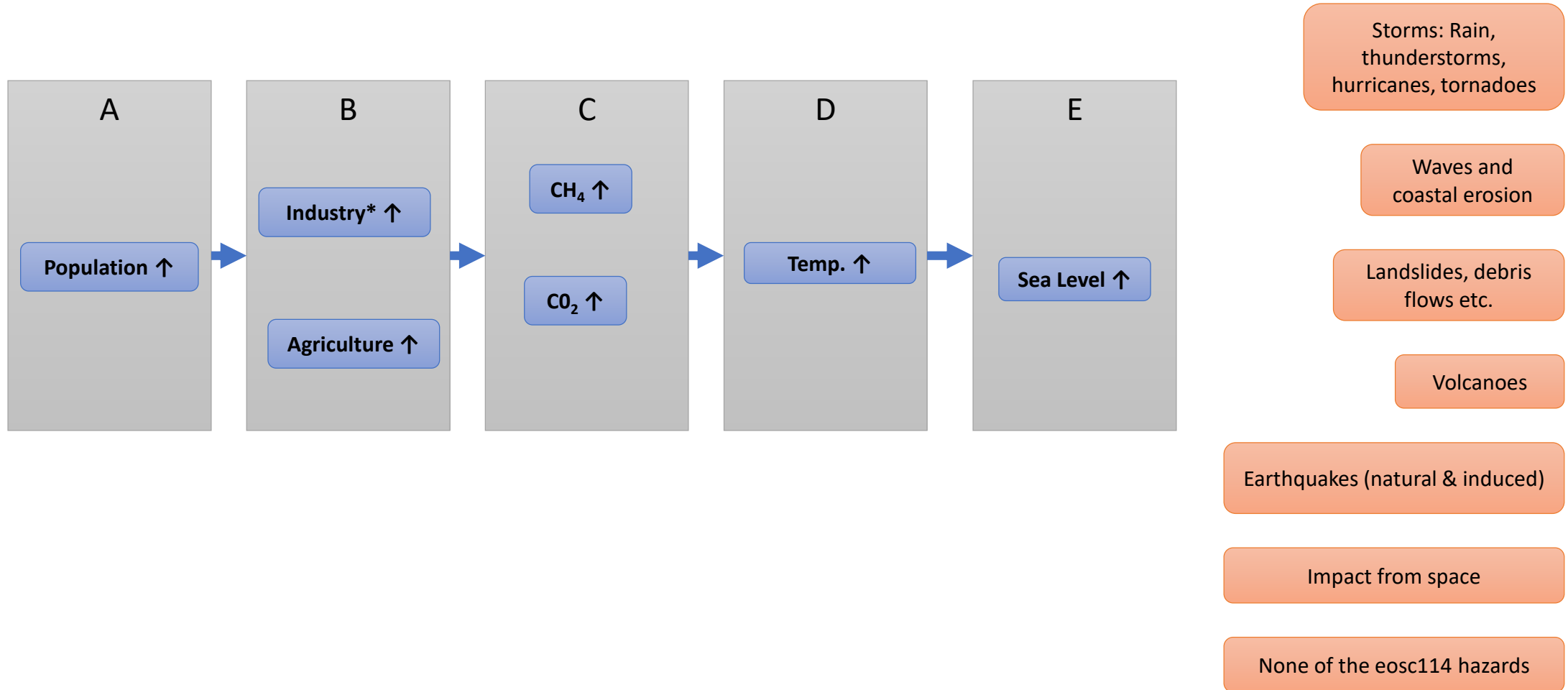
A	B	C	D	E
Population ↑	Industry* ↑ Agriculture ↑	CH_4 ↑ CO_2 ↑	Temp. ↑	Sea Level ↑

Storms: Rain, thunderstorms, hurricanes, tornadoes

Waves and coastal erosion

Landslides, debris flows etc.

Volcanoes

Earthquakes (natural & induced)

Impact from space

None of the eosc114 hazards

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

PART IIIa: solution

Put hazard(s) caused DIRECTLY by increases in A into GREEN box.

Write a (very) short explanation of how factors in A can cause increases in frequency or severity of hazards you place in the GREEN box.

A

Population ↑

Storms: Rain, thunderstorms, hurricanes, tornadoes

Waves and coastal erosion

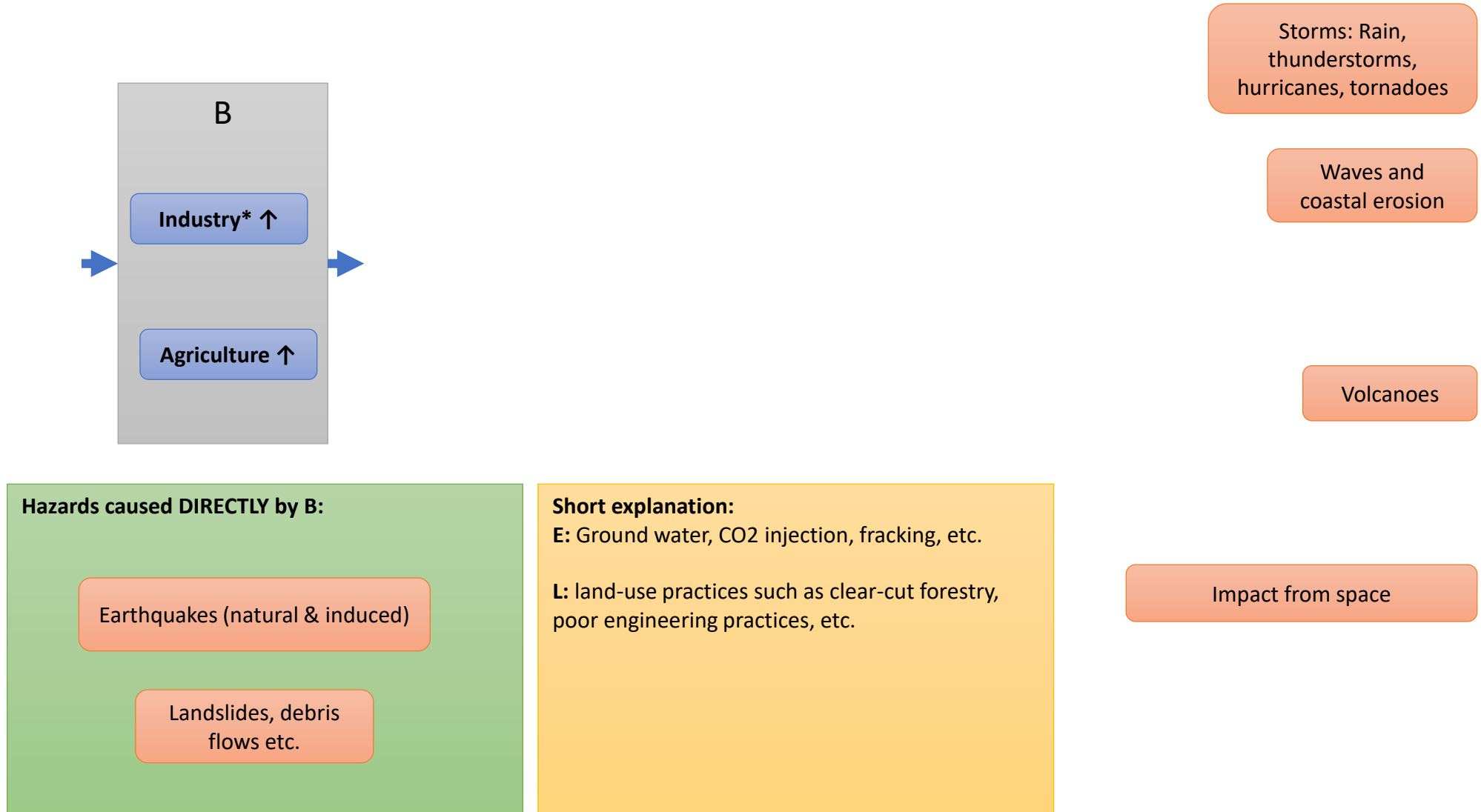Landslides, debris flows etc.

Volcanoes

Earthquakes (natural & induced)

Impact from space

Hazards caused DIRECTLY by A:

None of the eosc114 hazards

Short explanation:

* Industry = energy production, transportation,
   materials (plastics, etc.), goods (not food)

PART IIIb: solution

Put hazard(s) caused DIRECTLY by increases in B into GREEN box.
Write a (very) short explanation of how factors in B can cause increases in frequency or severity of hazards you place in the GREEN box.
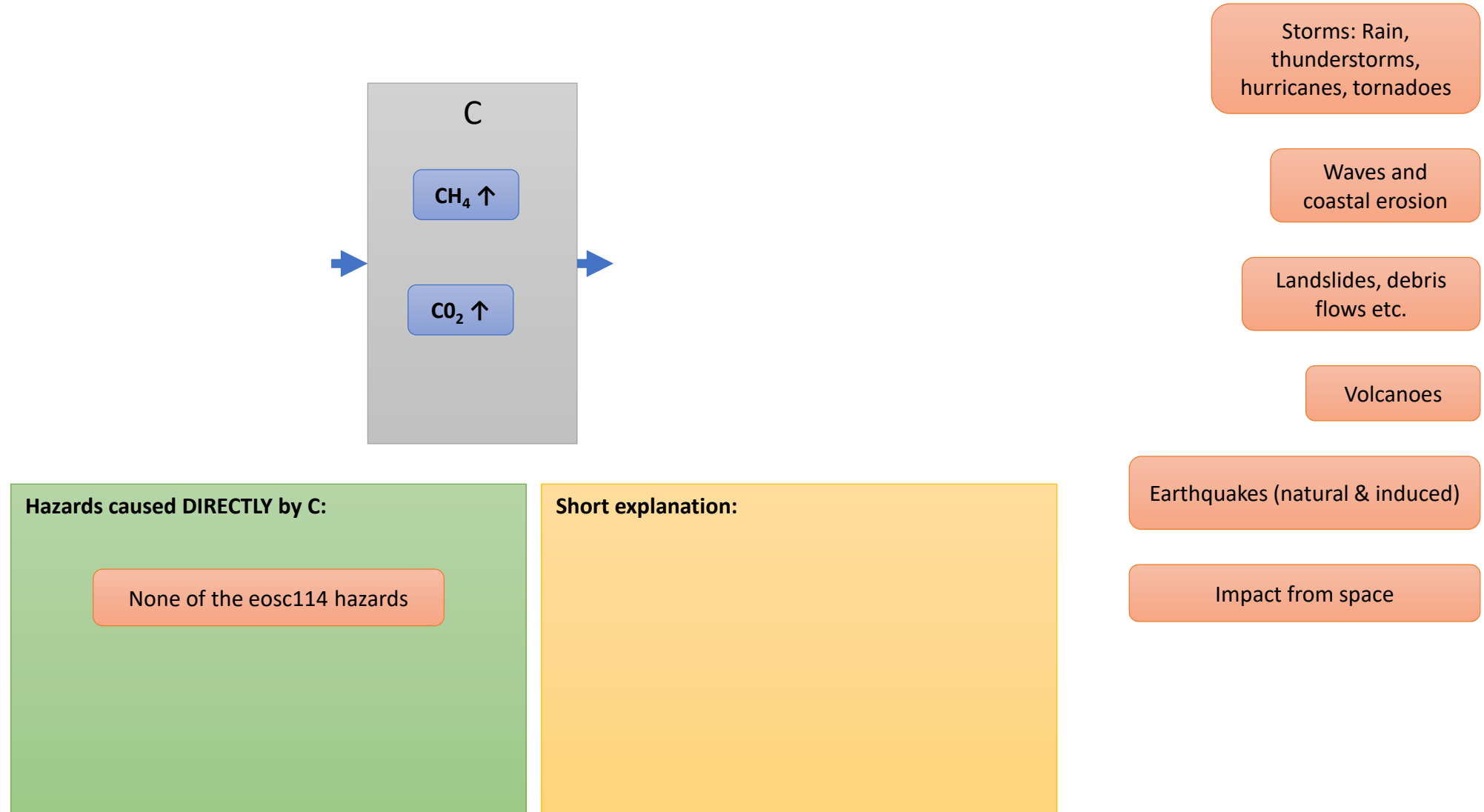
B

Industry* ↑

Agriculture ↑

Storms: Rain, thunderstorms, hurricanes, tornadoes

Waves and coastal erosion

Volcanoes

Impact from space

Hazards caused DIRECTLY by B:

Earthquakes (natural & induced)

Landslides, debris flows etc.

Short explanation:
E: Ground water, CO2 injection, fracking, etc.

L: land-use practices such as clear-cut forestry, poor engineering practices, etc.

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

PART IIIc: solution

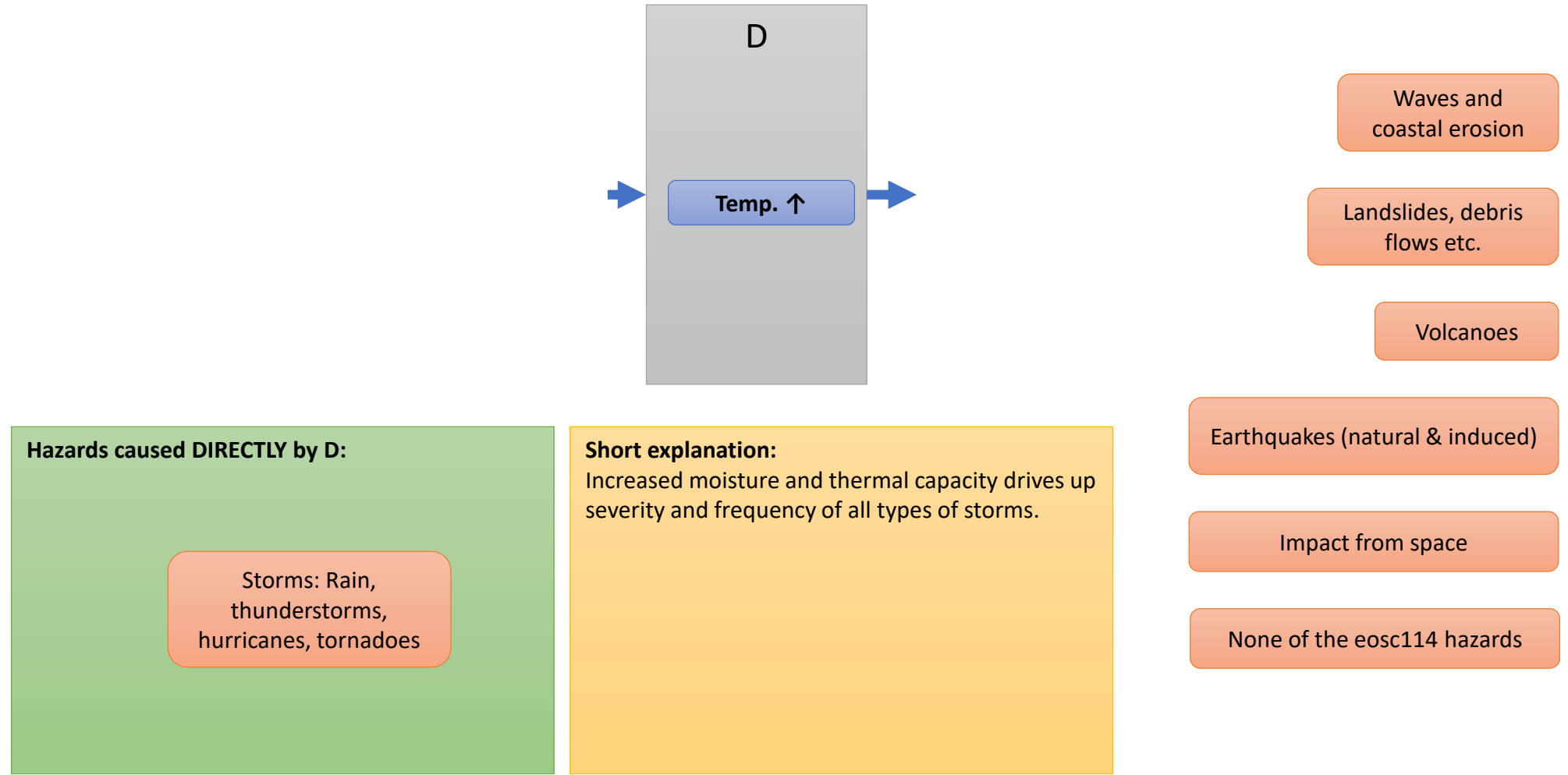Put hazard(s) caused DIRECTLY by increases in C into GREEN box.

Write a (very) short explanation of how factors in C can cause increases in frequency or severity of hazards you place in the GREEN box.

C

CH_4 ↑

CO_2 ↑

Storms: Rain, thunderstorms, hurricanes, tornadoes

Waves and coastal erosion

Landslides, debris flows etc.

Volcanoes

Earthquakes (natural & induced)

Impact from space

Hazards caused DIRECTLY by C:

None of the eosc114 hazards

Short explanation:

* Industry = energy production, transportation,
   materials (plastics, etc.), goods (not food)

PART IIId: solution
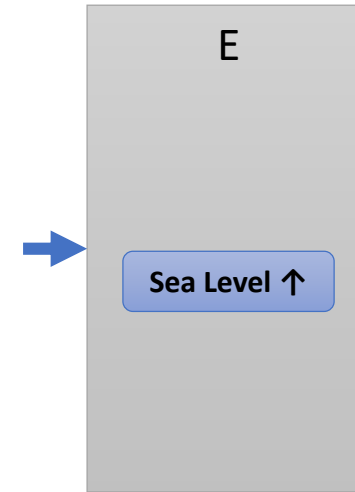Put hazard(s) caused DIRECTLY by increases in D into GREEN box.

D

Temp. ↑

Waves and coastal erosion

Landslides, debris flows etc.

Volcanoes

Earthquakes (natural & induced)

Hazards caused DIRECTLY by D:

Storms: Rain, thunderstorms, hurricanes, tornadoes

Short explanation:
Increased moisture and thermal capacity drives up severity and frequency of all types of storms.

Impact from space

None of the eosc114 hazards

* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

PART IIIe: solution
Put hazard(s) caused DIRECTLY by increases in E into GREEN box.
Write a (very) short explanation of how factors in E can cause increases in frequency or severity of hazards you place in the GREEN box.

Storms: Rain, thunderstorms, hurricanes, tornadoes

E

Sea Level ↑

Impact from space

None of the eosc114 hazards

Hazards caused DIRECTLY by E:

Waves and coastal erosion

Volcanoes

Earthquakes (natural & induced)

Short explanation:
Sea level rise causes increased frequency and severity of coastal erosion and wave actions.

Shifting tectonics may have some effect on volcanoes and earthquakes (but poorly determined).
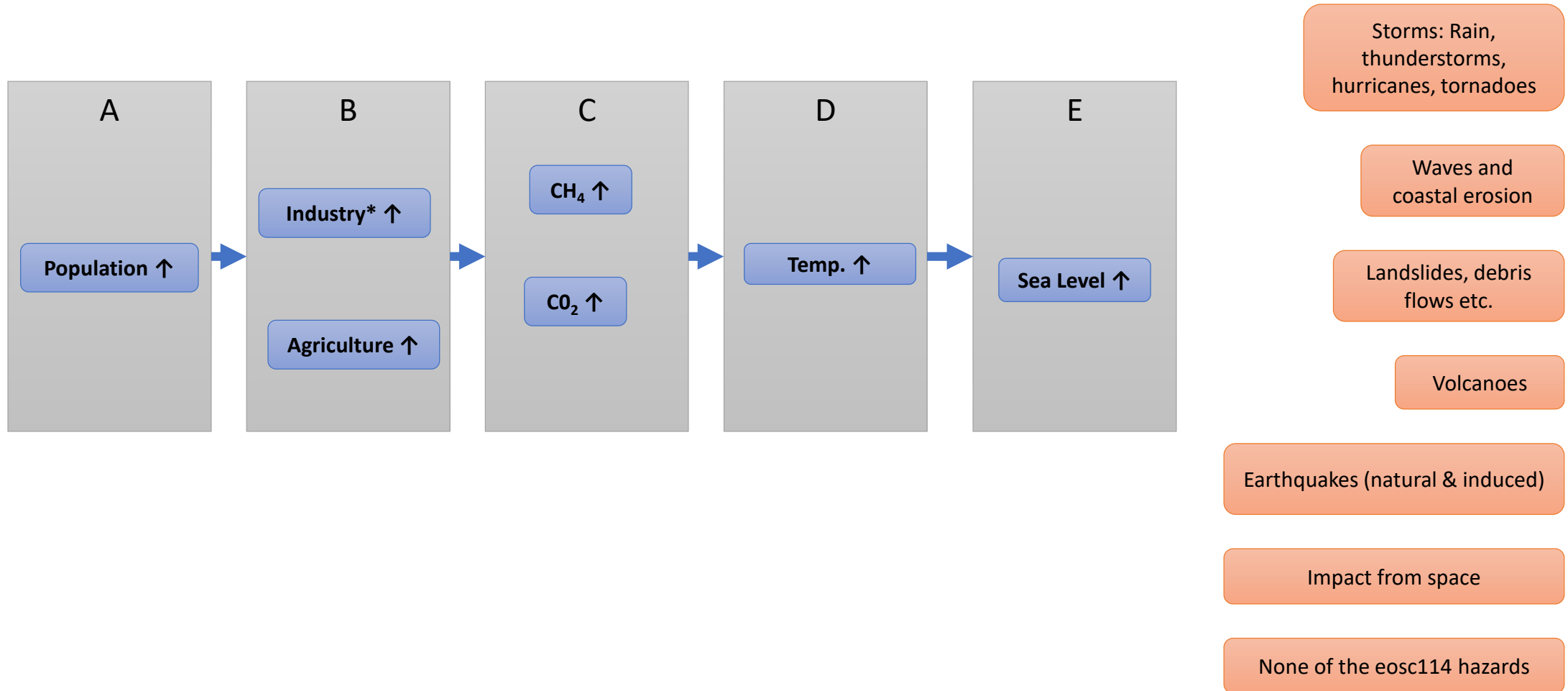
* Industry = energy production, transportation, materials (plastics, etc.), goods (not food)

PART IV:

So far, you have considered the possible impacts of increasing "factors" on the frequency or severity of natural hazards.

A	B	C	D	E
Population ↑	**Industry* ↑** **Agriculture ↑**	**CH$_4$ ↑** **CO$_2$ ↑**	**Temp. ↑**	**Sea Level ↑**

Storms: Rain, thunderstorms, hurricanes, tornadoes

Waves and coastal erosion

Landslides, debris flows etc.

Volcanoes

Earthquakes (natural & induced)

Impact from space

None of the eosc114 hazards

* Industry = energy production, transportation,
   materials (plastics, etc.), goods (not food)

PART IV-a:

So far, you have considered impacts of increasing "factors" on frequency or severity of natural hazards.
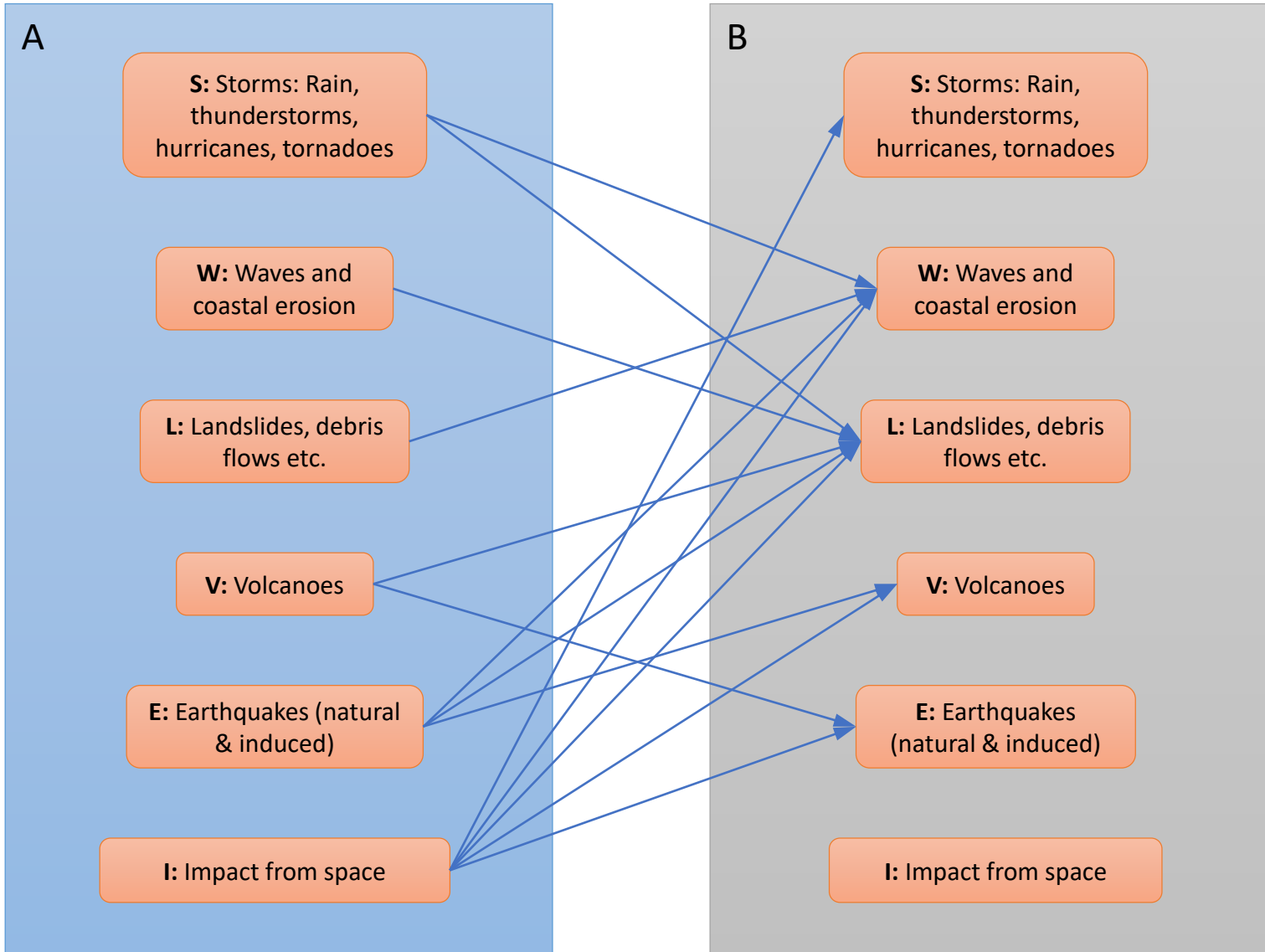
NOW, consider how increases in severity or frequency of **hazard types** may affect increase or severity of OTHER hazards.

ADD lines or arrows indicating which natural hazard can contribute to causing other hazards in B. The first is done as an example.
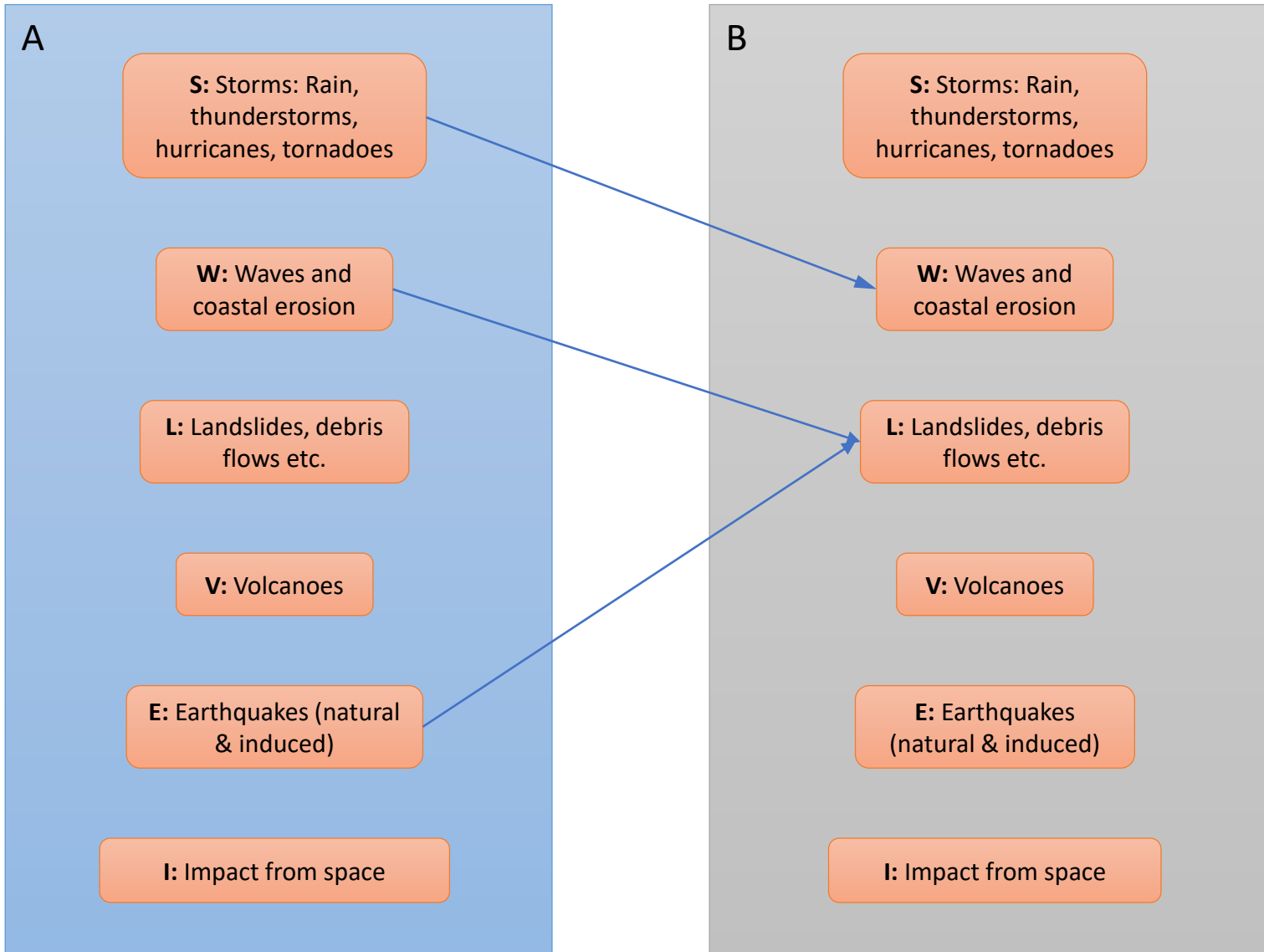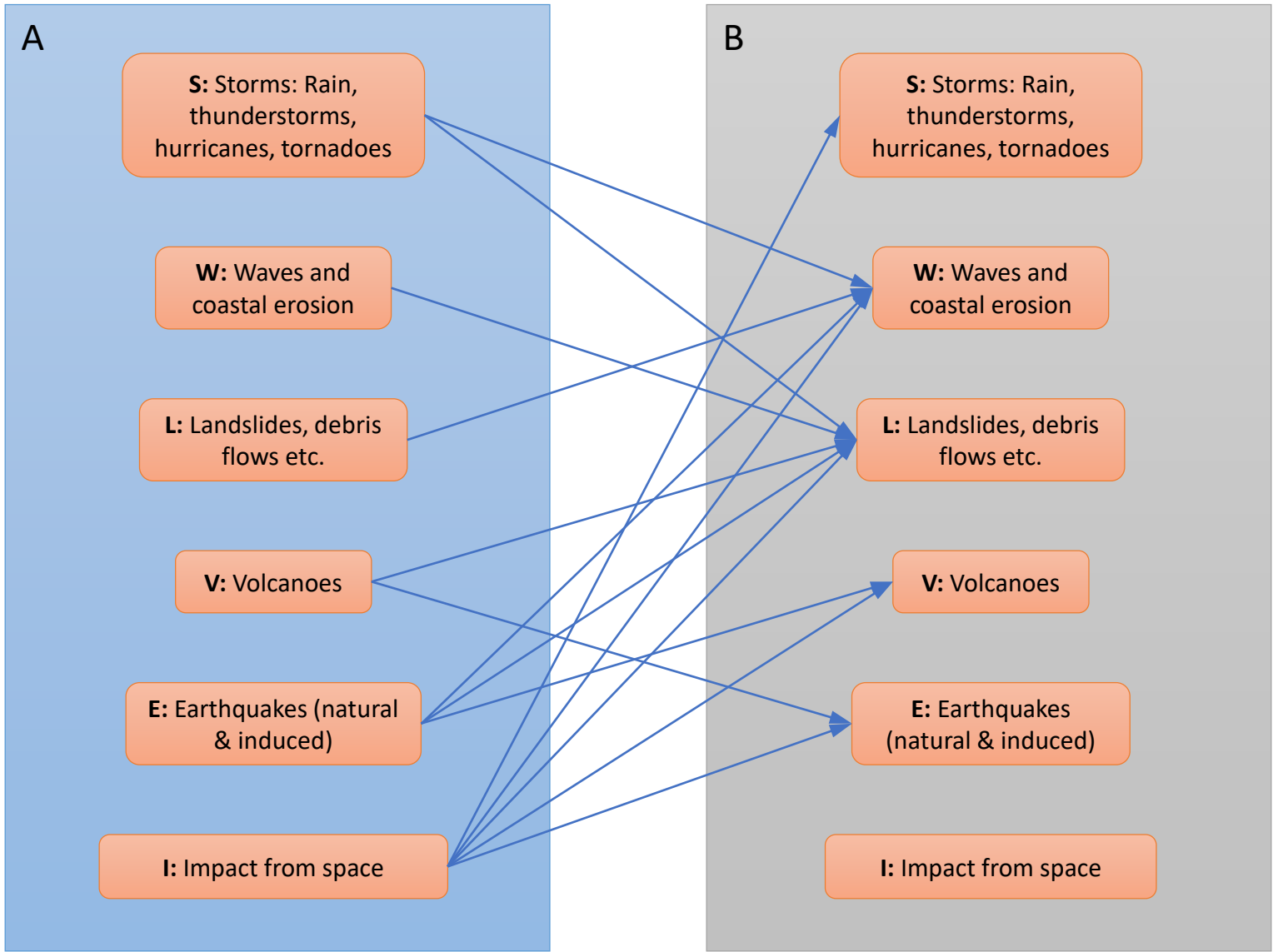
PART IV-a: solution

So far, you have considered impacts of increasing "factors" on frequency or severity of natural hazards.

NOW, consider how increases in severity or frequency of hazard types may affect increase or severity of OTHER hazards.

ADD arrows indicating which natural hazard can contribute to causing other hazards in B.

A

S: Storms: Rain, thunderstorms, hurricanes, tornadoes

W: Waves and coastal erosion

L: Landslides, debris flows etc.

V: Volcanoes

E: Earthquakes (natural & induced)

I: Impact from space

B

S: Storms: Rain, thunderstorms, hurricanes, tornadoes

W: Waves and coastal erosion

L: Landslides, debris flows etc.

V: Volcanoes

E: Earthquakes (natural & induced)

I: Impact from space

PART IV-b:

So far, you have considered impacts of increasing "factors" on frequency or severity of natural hazards.

NOW, consider how increases in severity or frequency of hazard types may affect increase or severity of OTHER hazards.

ADD arrows indicating which natural hazard can contribute to causing other hazards in B.

Explain briefly at least one way that each "A" hazard can cause or induce a "B" hazard via each line or arrow. The first is done as an example.

A

- **S:** Storms: Rain, thunderstorms, hurricanes, tornadoes
- **W:** Waves and coastal erosion
- **L:** Landslides, debris flows etc.
- **V:** Volcanoes
- **E:** Earthquakes (natural & induced)
- **I:** Impact from space

B

- **S:** Storms: Rain, thunderstorms, hurricanes, tornadoes
- **W:** Waves and coastal erosion
- **L:** Landslides, debris flows etc.
- **V:** Volcanoes
- **E:** Earthquakes (natural & induced)
- **I:** Impact from space

Explain how A can cause B.

S -> W: Storms & hurricanes cause large waves and can rapidly erode coastal regions.

S -> L:
W > L:
L > W:
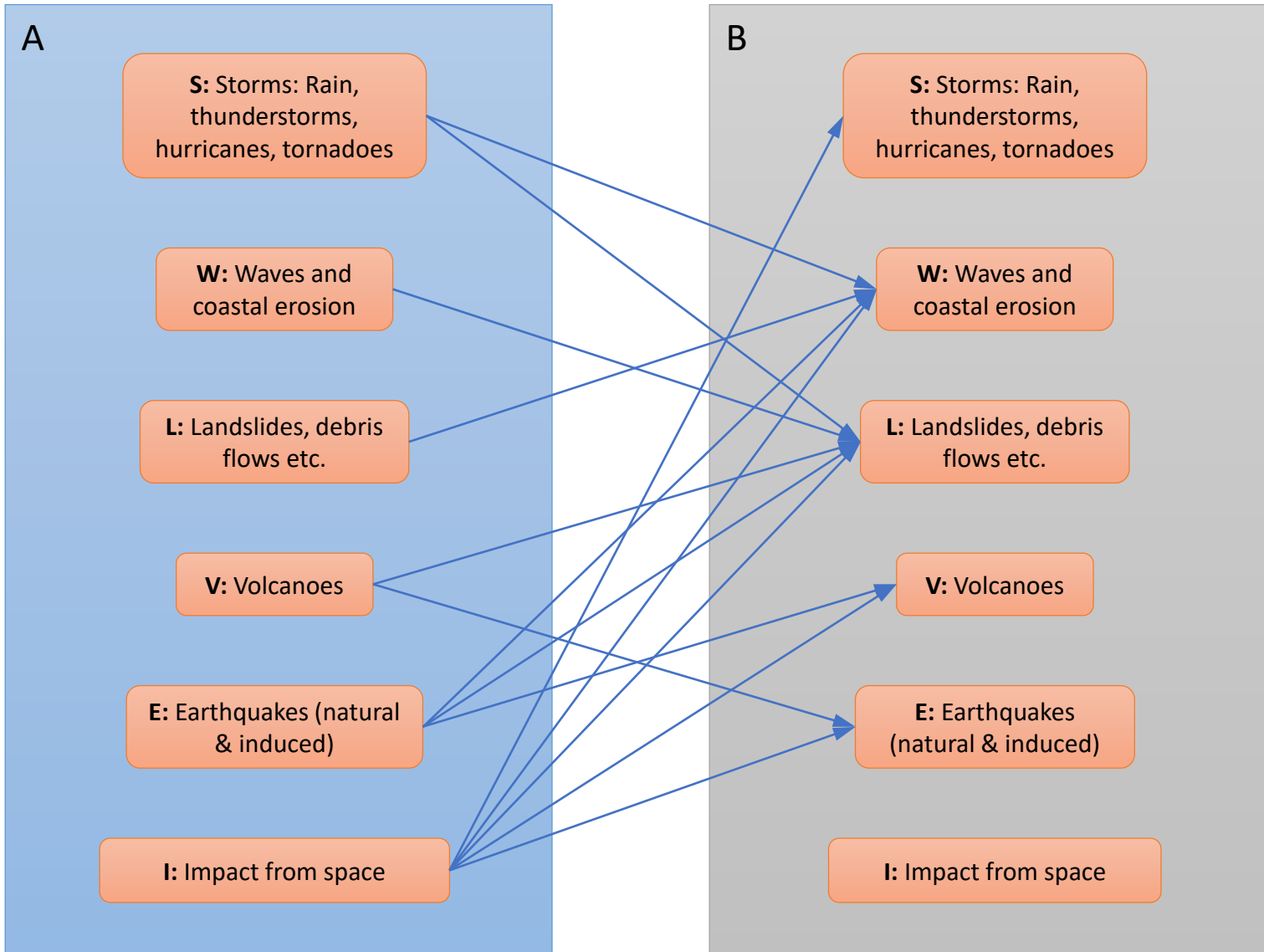V > L:
V > E:
E > W:
E > L:
E > V:
I > All:

PART IV-b solution:
So far, you have considered impacts of increasing "factors" on frequency or severity of natural hazards.
NOW, consider how increases in severity or frequency of hazard types may affect increase or severity of OTHER hazards.
ADD arrows indicating which natural hazard can contribute to causing other hazards in B.
OPTIONAL: give at least one way that each "A" hazard can cause or induce a "B" hazard via each line or arrow. The first is done as an example

A

S: Storms: Rain, thunderstorms, hurricanes, tornadoes

W: Waves and coastal erosion

L: Landslides, debris flows etc.

V: Volcanoes

E: Earthquakes (natural & induced)

I: Impact from space

B

S: Storms: Rain, thunderstorms, hurricanes, tornadoes

W: Waves and coastal erosion

L: Landslides, debris flows etc.

V: Volcanoes

E: Earthquakes (natural & induced)

I: Impact from space

Explain how A can cause B.

S -> W: Storms & hurricanes cause large waves and can rapidly erode coastal regions.

S -> L:
W > L:
L > W:
V > L:
V > E:
E > W:
E > L:
E > V:
I > All:

See FJ's mindmap, slide 2

PART V:
Write 1 or 2 sentences to summarize an important "lesson learned" by considering the relationships between causative factors, natural hazards, and between the hazards themselves.

Answer:

PART V: solution

Write 1 or 2 sentences to summarize a "lesson learned" but considering the relationships between causative factors, natural hazards, and between the hazards them selves.

Answer:

The moral of the story is that human activity, climate, and natural hazards are tightly coupled, and the relationships between causes, other causes and effects are complex.