
Welcome

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Let's introduce who we are

CEUWM

CANADA EGYPT UGANDA WATER MISSION

Get to our website from here

Presentation outline:

- Introduction
- Brief Mission Overview
- Impact Analysis
- Mission Requirements
- Design Analysis
- Project Management
- Recommendations and next steps
- Conclusion

Intro

The CEUWM is a microsatellite mission with the objective of assessing the health of coastal and inland waters for Northern Canada and Uganda.

Our Program

3-week pilot

Proposed 4-year program

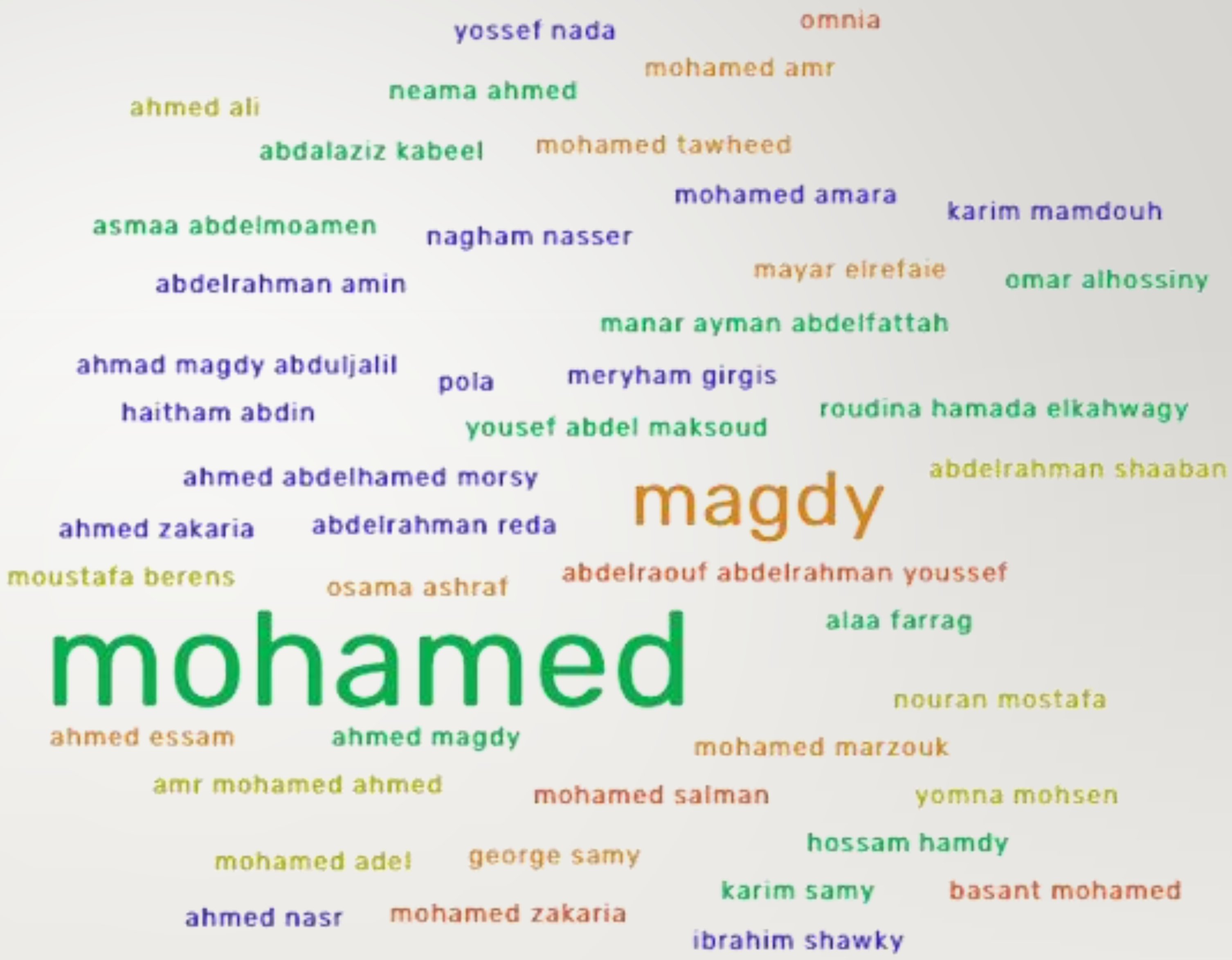
Subgroups

PROGRAM MANAGEMENT

MISSION DESIGN

IMPACT

Our Team


yossef nada
omnia
mohamed amr
neama ahmed
ahmed ali
abdalaziz kabeel
mohamed tawheed
mohamed amara
karim mamdouh
asmaa abdelmoamen
nagham nasser
mayar elrefaie
omar alhossiny
abdelrahman amin
manar ayman abdelfattah
ahmad magdy abduljalil
pola
meryham girgis
haitham abdin
yousef abdel maksoud
roudina hamada elkahwagy
ahmed abdelhamed morsy
magdy
abdelrahman shaaban
ahmed zakaria
abdelrahman reda
moustafa berens
osama ashraf
abdelraouf abdelrahman youssef
alaa farrag
mohamed
nouran mostafa
ahmed essam
ahmed magdy
mohamed marzouk
amr mohamed ahmed
mohamed salman
yomna mohsen
hossam hamdy
mohamed adel
george samy
karim samy
basant mohamed
ahmed nasr
mohamed zakaria
ibrahim shawky

ABOUT THE TEAM

- The team is a chain of 3 sub-teams working collaboratively to achieve the ultimate goals of this mission . We employ fair and just methods of collaboration where all team members have a seat at the table where "No voice is ignored".

The Water Problem

WHAT ARE WE
EVEN TRYING
TO SOLVE?

CANADA ISSUES

Land Acknowledgement
(considering Northern Canada communities)

- York University recognizes that many Indigenous Nations have longstanding relationships with the territories upon which York University campuses are located that precede the establishment of York University. York University acknowledges its presence on the traditional territory of many Indigenous Nations. The area known as Tkaronto has been care-taken by the Anishinabek Nation, the Haudenosaunee Confederacy, and the Huron-Wendat.

- It is now home to many First Nation, Inuit and Métis communities. We acknowledge the current treaty holders, the Mississaugas of the Credit First Nation. This territory is subject of the Dish with One Spoon Wampum Belt Covenant, an agreement to peaceably share and care for the Great Lakes region.

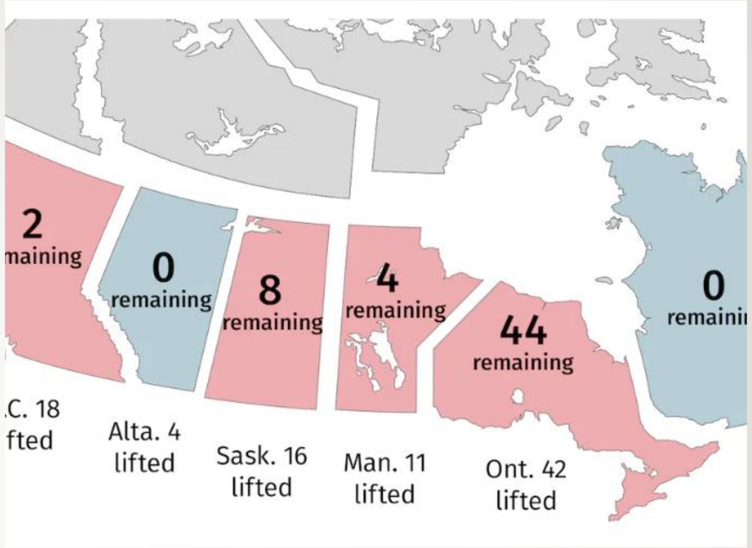
https://native-land.ca/

There are about 835 water advisories around us

Based on last year's Data

The Issue

- 58 Long term water Advisories remain open
- Affects daily life (bathing, cooking, cleaning)
- Flu-like symptoms from drinking the water without boiling
- Reserves fall under the jurisdiction of the federal government, but they doesn't monitor all the water going into building from cisterns and wells.
- Neskantaga First Nation has been on a long-term boil advisory since 1995



Based on last year's Data

UGNANDA ISSUES

The Issue

- 7 million Ugandans lack access to safe water
- 28 million do not have access to improved sanitation facilities.
- People walk for 6 hours daily to have access to water
- People in rural areas cannot have their voices heard.
- Nevertheless, there are a lot of diseases that affect people from poor water quality.
- Uganda has 45% of Viktoria lake which is one of Africa’s most important water sources in its territory.

Mission Overview – why do we think the world needs this mission

Change	Measure	Provide	Provide	Provide (new)
Change education by learning on the job through an engineering project	Measure impacts and allow for transparent decision making throughout the mission and with stakeholders	Provide water quality measurements in northern Canadian communities operable by those in the communities	Provide SMS in northern communities. Operated by communities	Provide water quality data to Uganda communities and other potential communities.

Mission Objectives

- Regional Water Quality Data for Northern Canadian and Uganda Communities.
- Sensor Information over 24H
- Alert Community Members
- Simple Messaging Service
- Configurable Data Reporting
- Joint Community Operations

Key Questions

Are our mission requirements appropriate?

Does this appear to constitute a useful mission?

Are our mission requirements complete?

Do we have a mission concept, program structure and impact structure that suggests this could be successful?

IMPACT TEAM

SAFE WATER SAFE LIFE

ABOUT US

- We are here to ensure that those who will be impacted by this project have a voice during every step of the design process. By bringing the communities' experiences and desires forward and working to keep them at the forefront of our minds, ensuring that this mission remains a collaboration, rather than a one-size-fits-all prescription.

- Team overview
- Why Uganda?
- Impact analysis
- Communication strategy

AGENDA

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GOALS

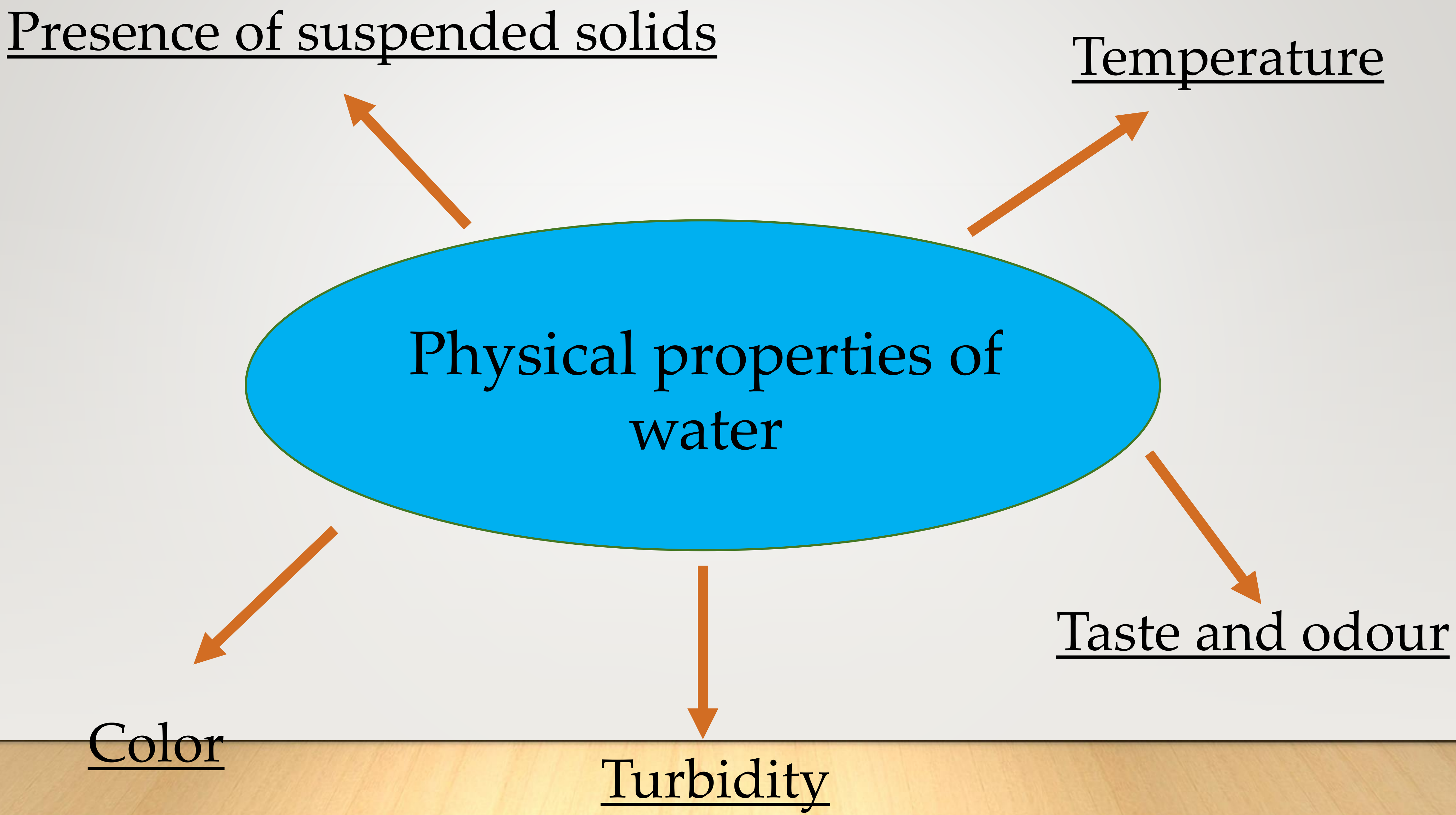
- Ensuring that the community is involved in making decisions by working with them and solving the water problem
- Adding a new area to the mission, Uganda
- Complete other unfinished tasks from last year
- Leaving a positive, sustainable impact on society

Water quality Parameters

Water quality parameters

Physical properties

Chemical parameters


Presence of suspended solids
Temperature
Physical properties of water
Taste and odour
Color
Turbidity

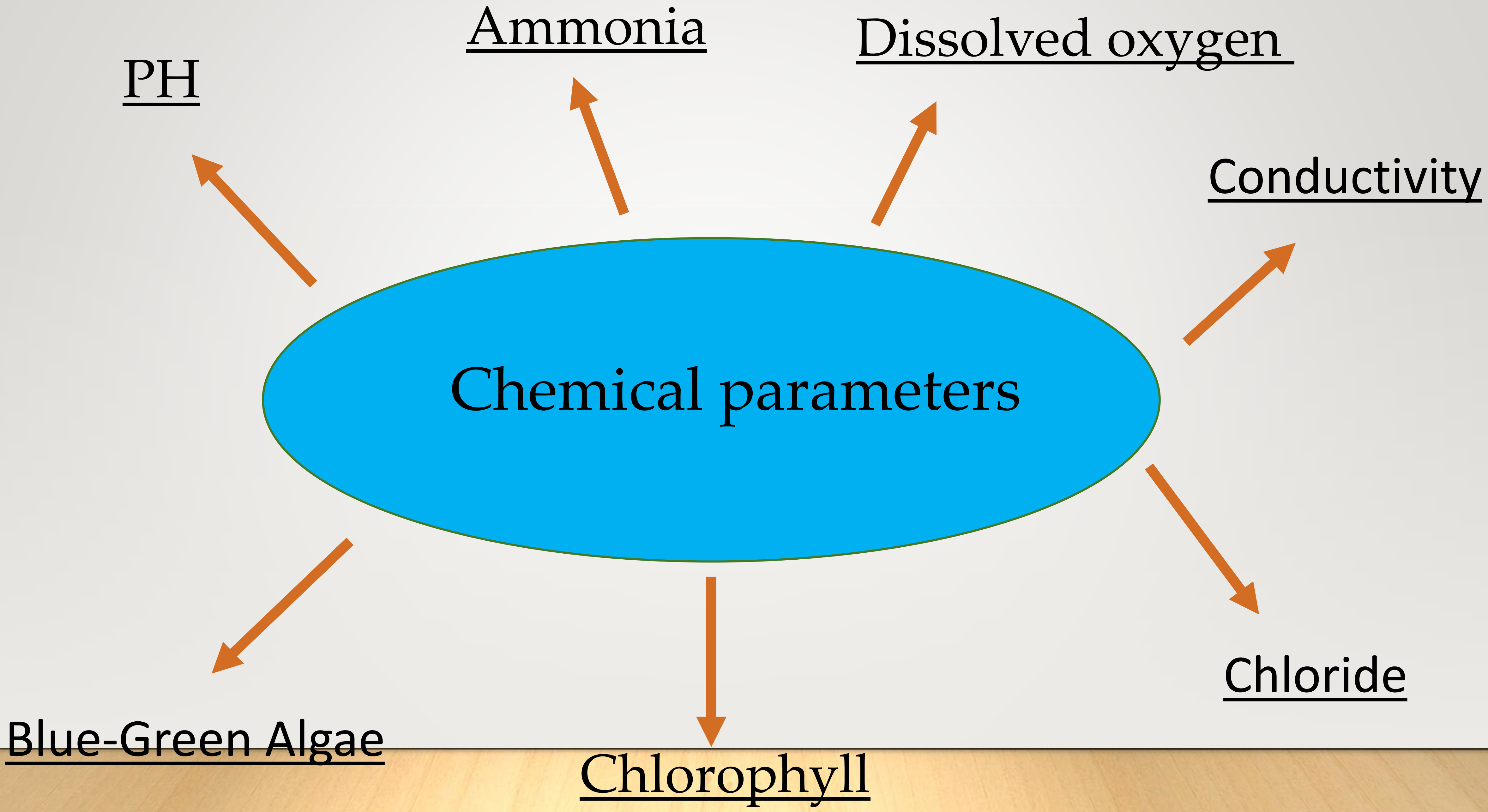
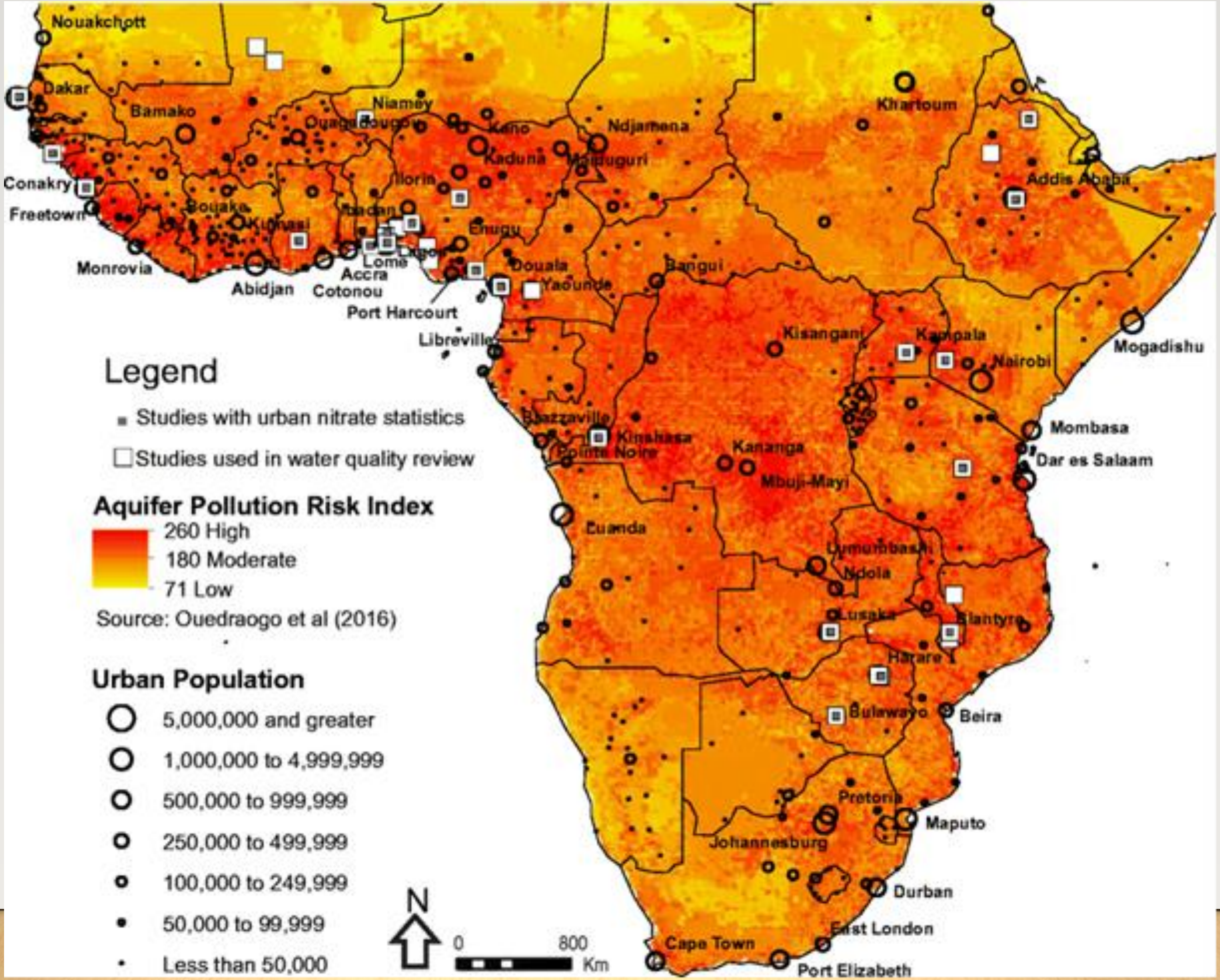

PH
Ammonia
Dissolved oxygen
Conductivity
Chemical parameters
Chloride
Blue-Green Algae
Chlorophyll

Table 3. Drinking water quality standards as recommended by FEPA and WHO.

*Parameter	FEPA[a] Standards	WHO[b] tandards
pH	6-9	6.5-9.2
Total Hardness	-	300
Total Dissolved Solid	2000	500
Electrical conductivity	-	300[c]
Total Coliform Count (100ml)	0	0
Sulphate	20	200
Sodium	-	200
Ammonium	0.01	1.5
Zinc	5.0	5.0
Iron	0.05	0.3
Lead	0.01	0.05
Cadmium	0.05	0.01

*All values in mg/L, except pH, EC (µS/cm) and Total coliform count (CFU/ml); [a] FEPA (1991), [b] WHO (1997), [c] WHO (2003).

Choosing Sites



Nouakchott
Dakar
Bamako
Niamey
Ouagadougou
Kano
Kaduna
Ndjamena
Maiduguri
Khartoum
Addis Ababa
Conakry
Freetown
Monrovia
Bouake
Kumasi
Ilorin
Ibadan
Enugu
Lome
Lagos
Accra
Abidjan
Cotonou
Port Harcourt
Douala
Yaounde
Bangui
Libreville
Kisangani
Kampala
Nairobi
Mogadishu
Mombasa
Dar es Salaam
Brazzaville
Kinshasa
Pointe Noire
Kananga
Mbuji-Mayi
Luanda
Lubumbashi
Ndola
Lusaka
Blantyre
Harare
Bulawayo
Beira
Pretoria
Maputo
Johannesburg
Durban
East London
Cape Town
Port Elizabeth
Legend
Studies with urban nitrate statistics
Studies used in water quality review
Aquifer Pollution Risk Index
260 High
180 Moderate
71 Low
Source: Ouedraogo et al (2016)
Urban Population
5,000,000 and greater
1,000,000 to 4,999,999
500,000 to 999,999
250,000 to 499,999
100,000 to 249,999
50,000 to 99,999
Less than 50,000
N
0
800
Km

African Countries on the Equator

Uganda

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Water Sources

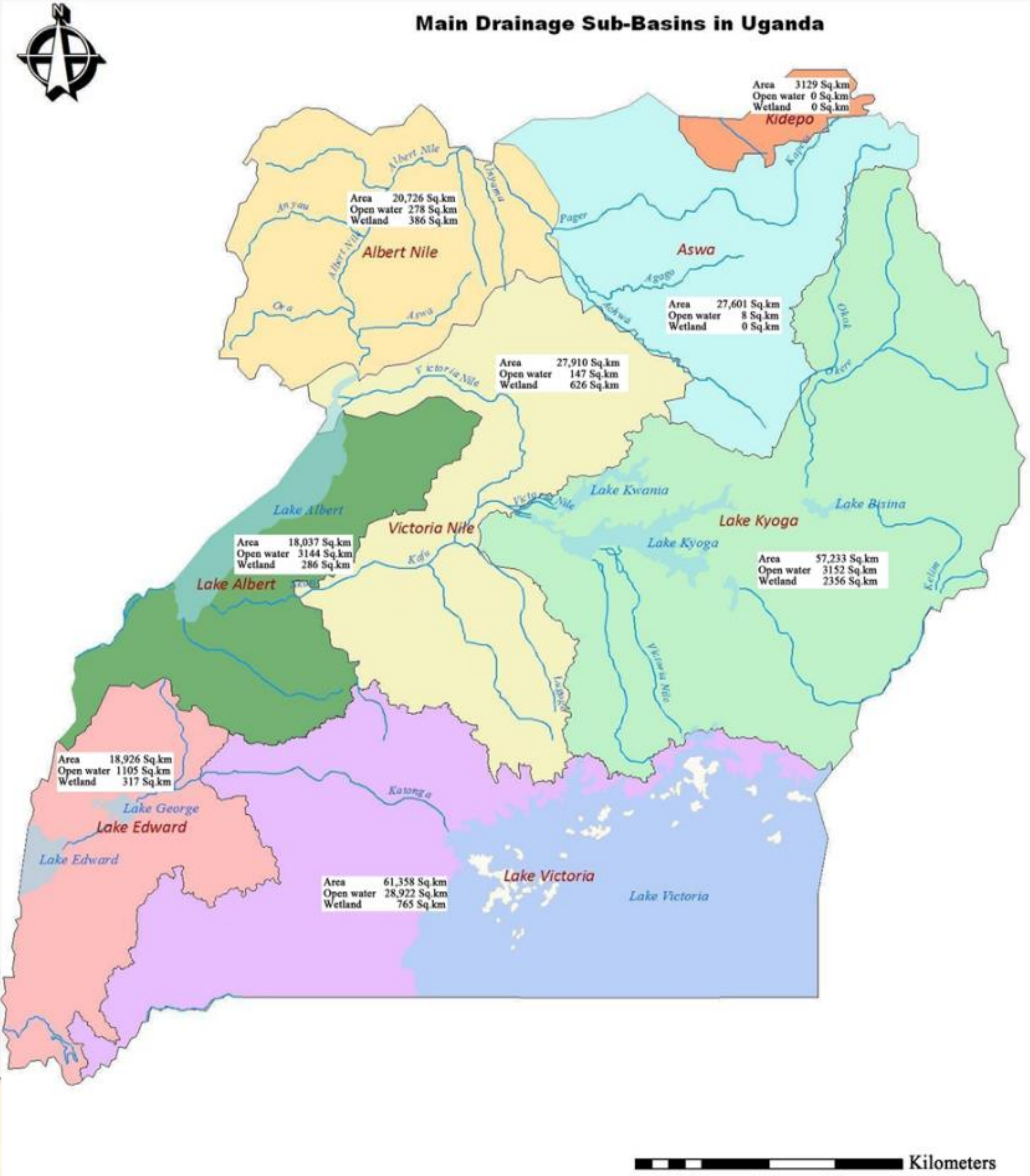
Lakes

- Lake Victoria
- Kyoga
- Albery

Rivers

- Nile River
- Kantoga
- Semliki

Rainfall, surface water runoff and ground water



SOURCE: Uganda National Water Development Report- 2005, modified to suit study

Uganda

Water Sources

Lakes

- Lake Victoria
- Kyoga
- Albery

Rivers

- Nile River
- Kantoga
- Semliki

Rainfall, surface water runoff and ground water

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Uganda

Rwizi River → pours in Victoria Lake → near Mbarara

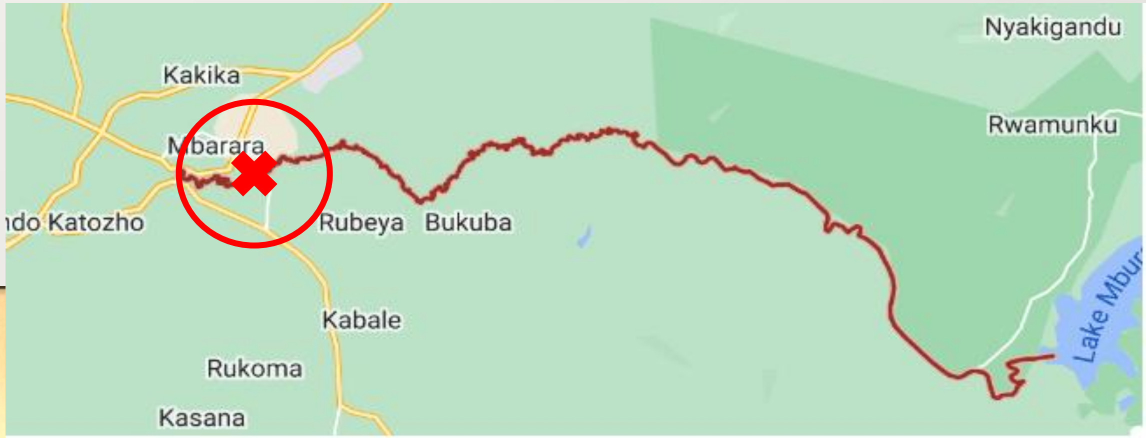
Nitrates

Bacteria & Microbes

Nile River Source near jinja

Bacteria & microbes

Nitrates & Phosphates

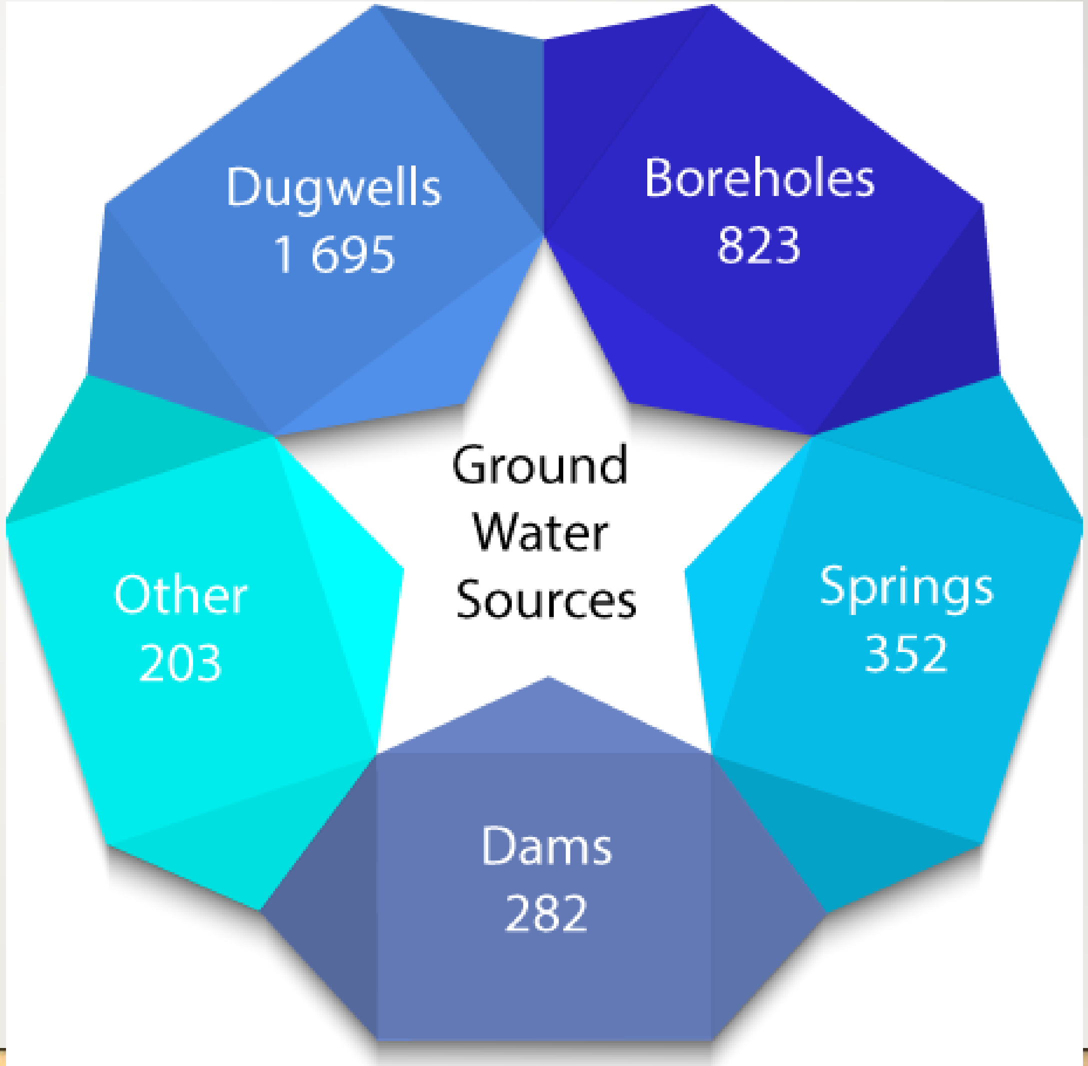


Somalia

Water Sources

Groundwater sources

- boreholes
- shallow wells
- springs



Somalia

Water Sources

Groundwater sources

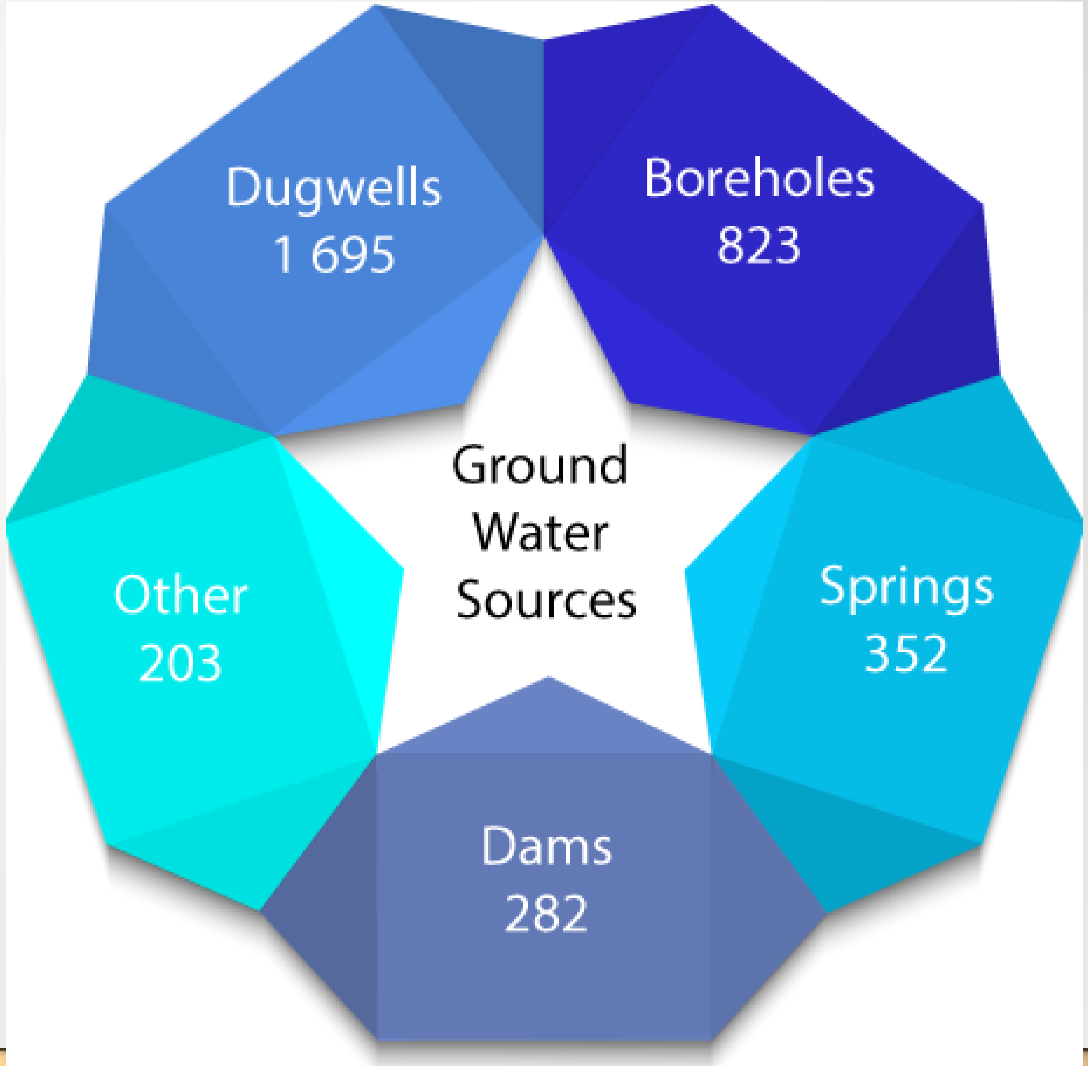
- boreholes
- shallow wells
- springs

Somalia

Random Groundwater sources

↓

Bacteria & microbes



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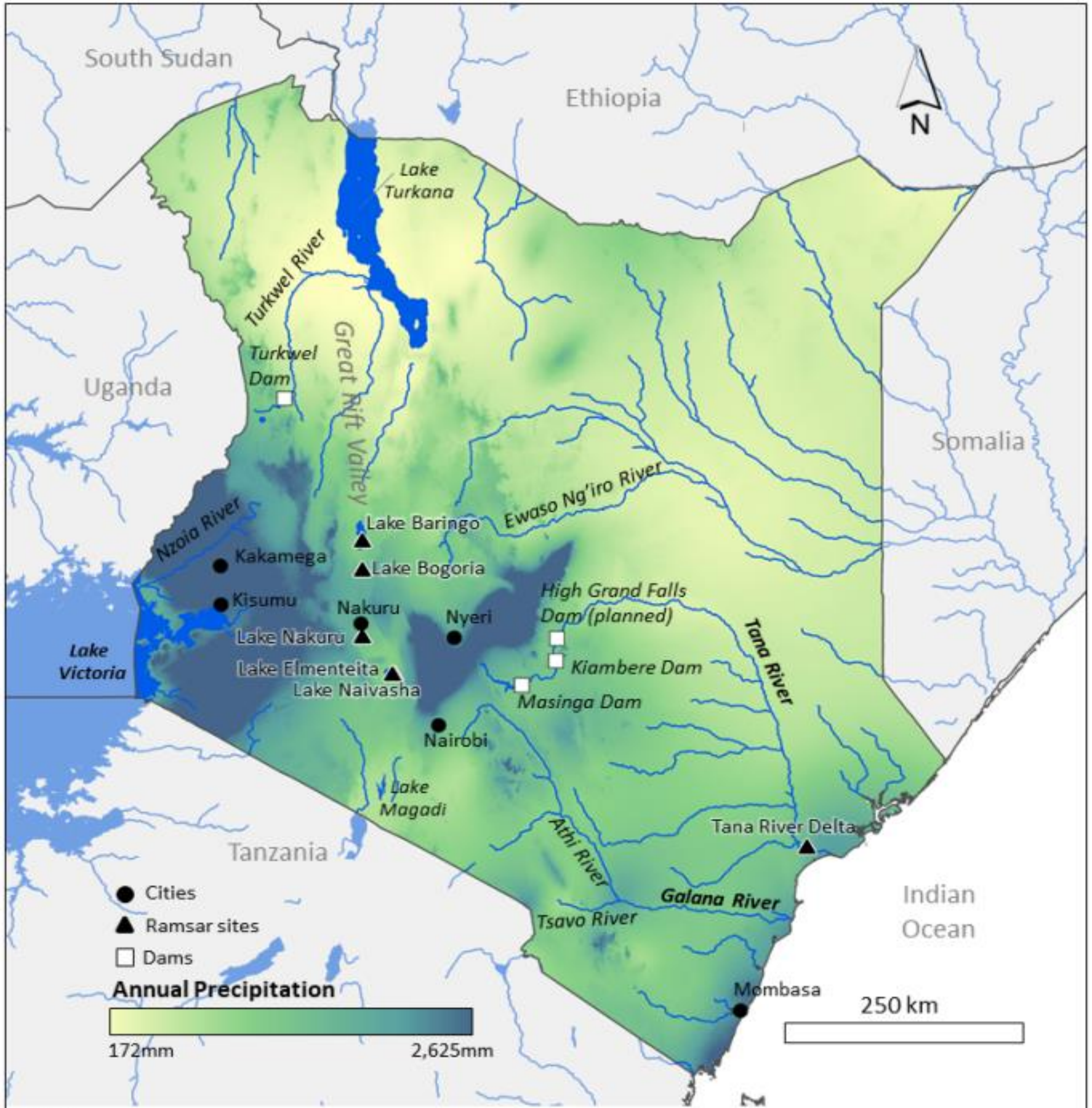
Kenya

Water Sources

2 Main surface water bodies

- Lake Victoria
- Tana River



Source:
Cities: World Cities – ArcGIS Hub, **Country Borders:** GADM, **Dams:** FAO Aquastat Dams Database, **Ramsar Sites:** Ramsar Sites Information Service, **Lakes and Wetlands:** WWF - GLWD (Level 1), **Rivers:** WWF – HydroRivers, **Precipitation:** WorldClim, **Flood and Drought:** WRI Aqueduct 2019

Kenya

Water Sources

2 Main surface water bodies

- Lake Victoria
- Tana River

Kenya

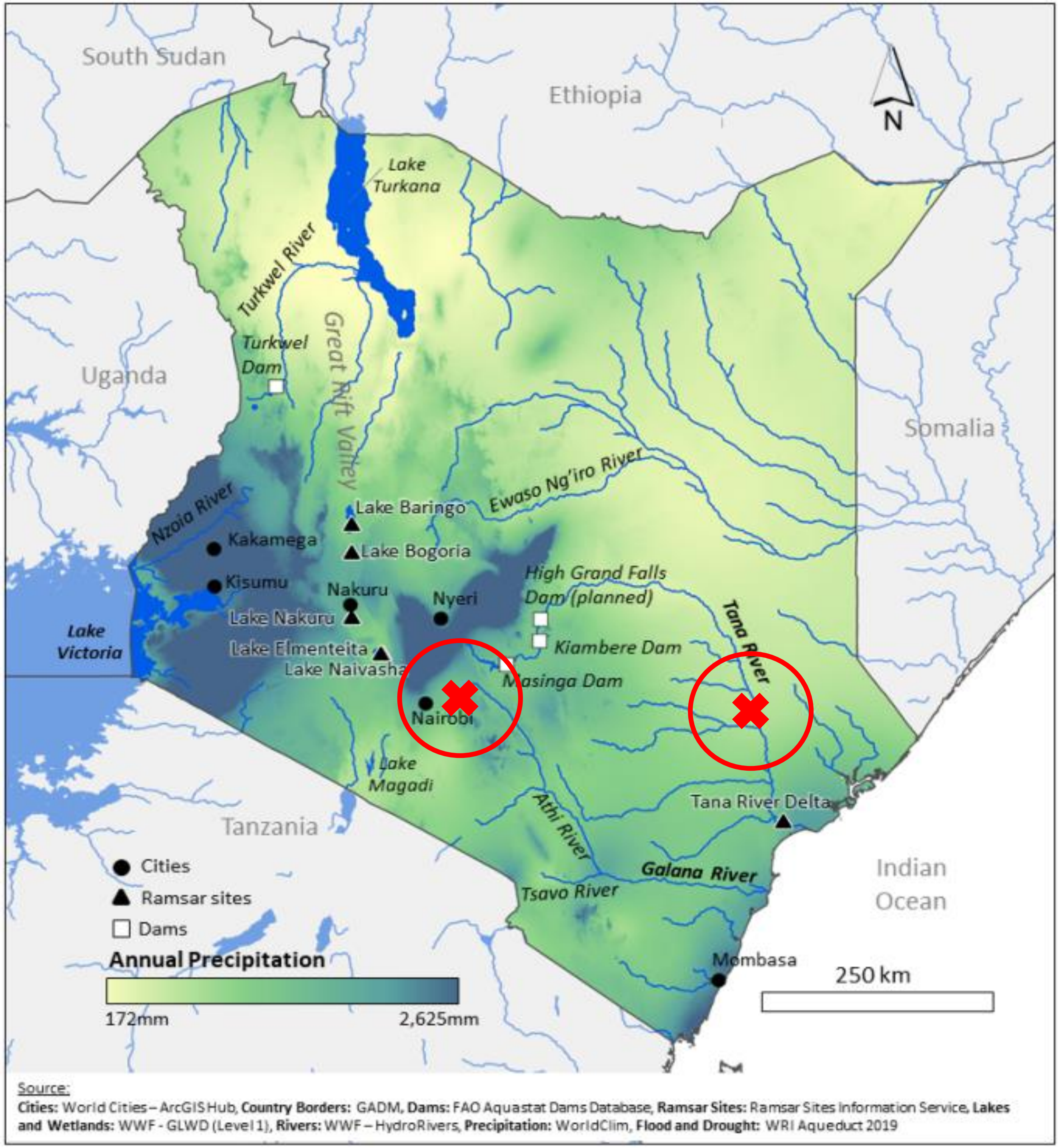
Tana River

Nitrates & phosphates

Pesticides

Athi River near Nairobi

PH Level



Gabon

Water Sources

The Ogooué River, some 1,200 kilometres (750 mi) long, is the principal river of Gabon in west central Africa and the fifth largest river in Africa by volume of discharge.

Gabon

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Gabon

The Ogooué River

↓

Between Franceville and Moanda

↓

fertilizers

↙ ↘

Nitrates Phosphates

Congo & Democratic Republic of Congo

Water Sources

Springs located in dense forests are the main source of water supply for the majority of the population.

Congo & Democratic Republic of Congo

Water Sources

Springs located in dense forests are the main source of water supply for the majority of the population.

Congo & Democratic Republic of Congo

Southern Katanga

PH Level

Bacteria & Microbes

Lake near Kinshasa

Nitrates & Phosphates

Deciding Factors for sites

Deciding Factors

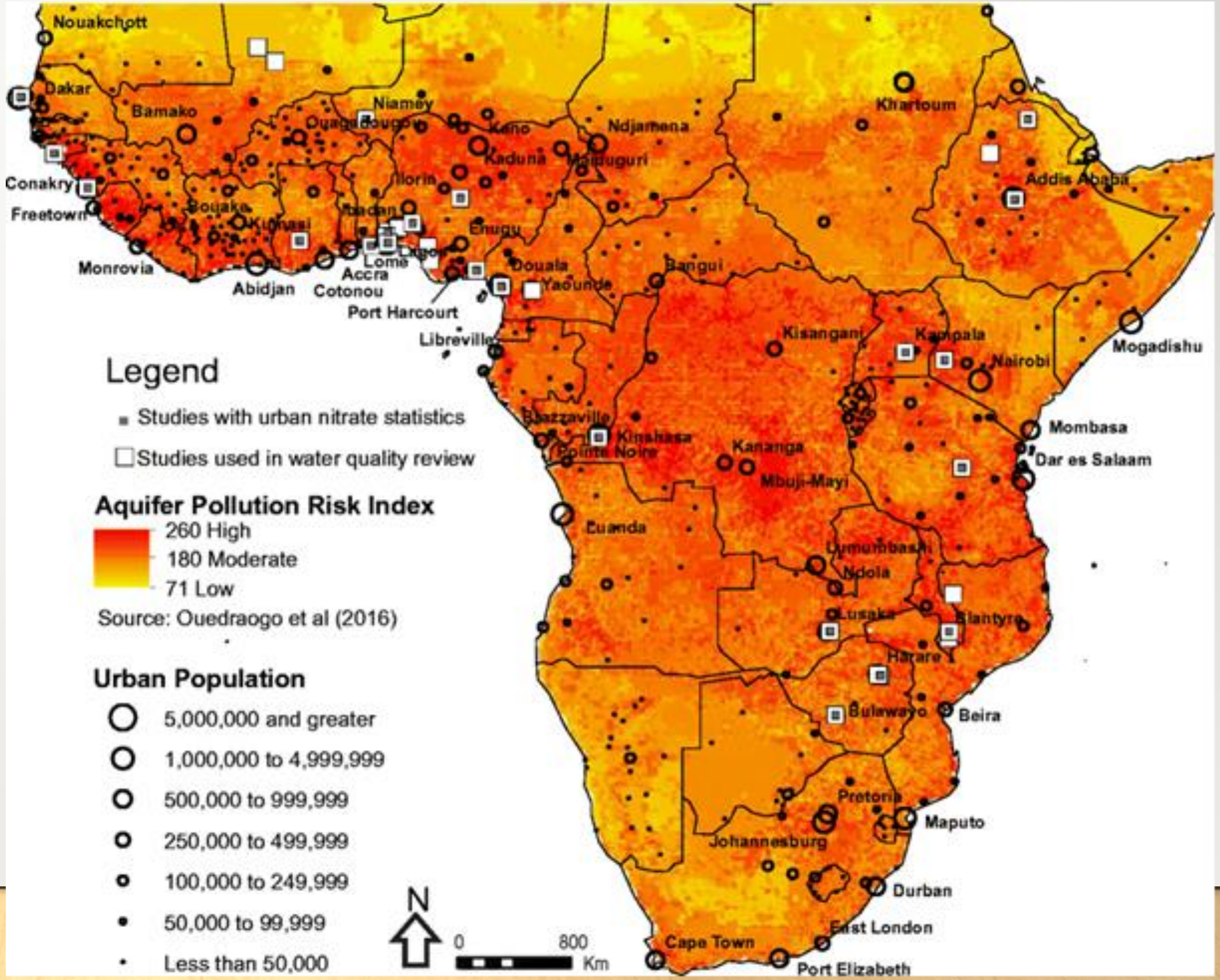
- Difficulty of mission (Mandatory)
- Water Contamination level
- Availability of Internet
- Impact on Africa's most important water sources

Difficulty of mission

Somalia, Congo and democratic Congo will be excluded as they depend mostly on groundwater like springs which require using sensors at multiple sites in each country making the mission harder

Water contamination level

Both Kenya and Uganda suffer from a high level of water contamination, but the case is worse in Uganda



Internet Availability

- 29.1 % of the population of Uganda use internet and low broadband speed
- 42 % of the population of Kenya use internet and much faster broadband speed

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Africa's most important water sources

Victoria Lake

Water volume of about 2,424 km^3

- supplies drinking water to around 10 million people
- Water for Livestock
- agricultural irrigation

Victoria Lake

Surface area of approximately 68,800 km^2

- Uganda has 45% (31,000 Km^2)
- Kenya has 6% of the total area (4,100 Km^2)

River Nile

Water volume of about 300M m^3

- More than 300 million people rely on the waters of the River Nile in 11 countries
- Water for Livestock
- agricultural irrigation

River Nile

Surface area of approximately
3,254,555 km^2

- Uganda considered one of the Nile River source countries

- Any pollution in the White River or Victoria Lake may affect all countries on the Nile basin

Final Choice

Uganda

- Two sites are recommended in Uganda: Victoria Lake and River Nile

- If only one site demanded, we would go for Victoria Lake

We originally wanted to work on all the African equator countries, but due to lack of time, we can only concentrate our efforts on one country.

So, we hope that next year other teams will be able to include more countries in the mission as these countries really need our help!

Impact Analysis Assessment

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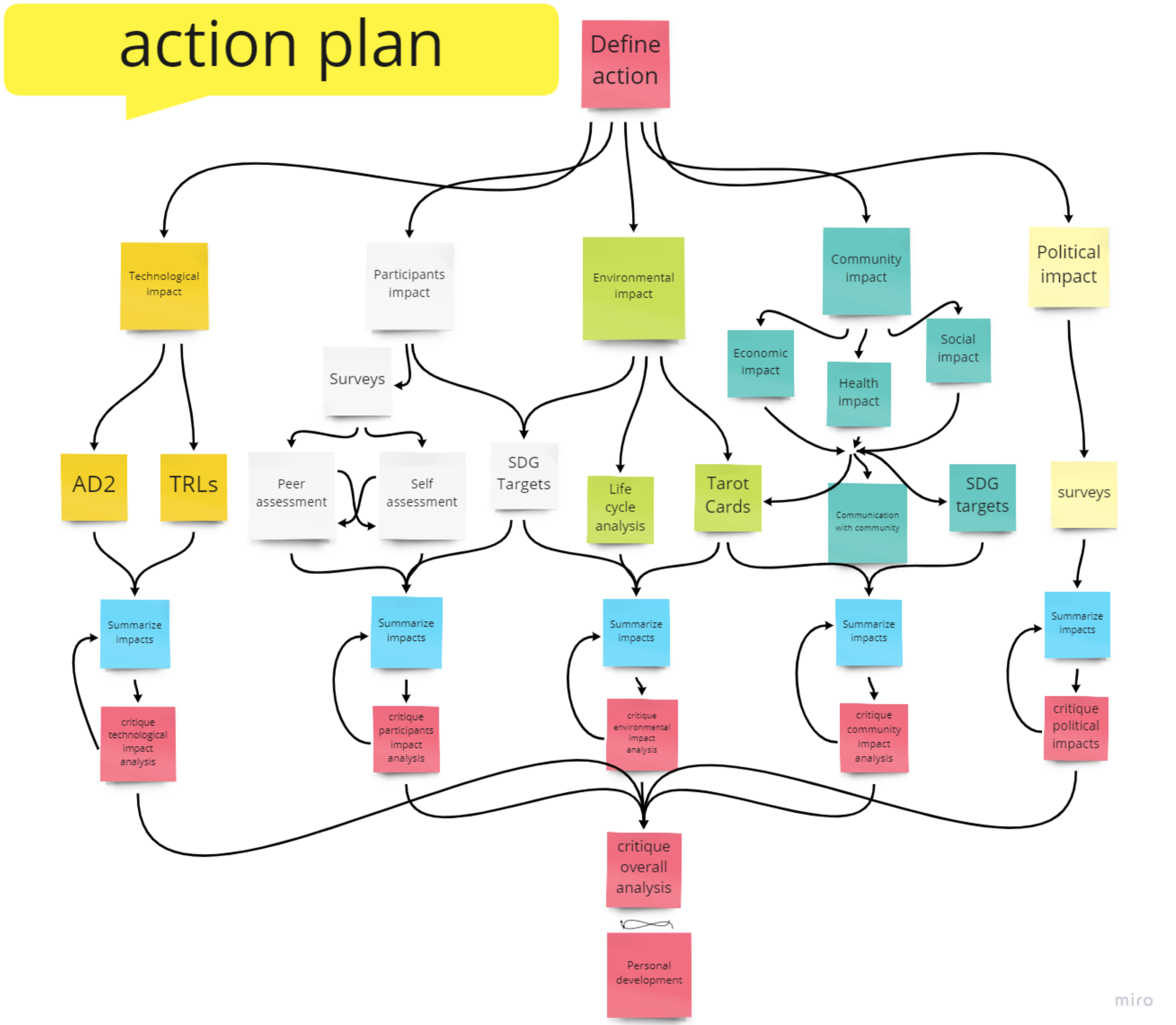
Defining an action

Types of impacts

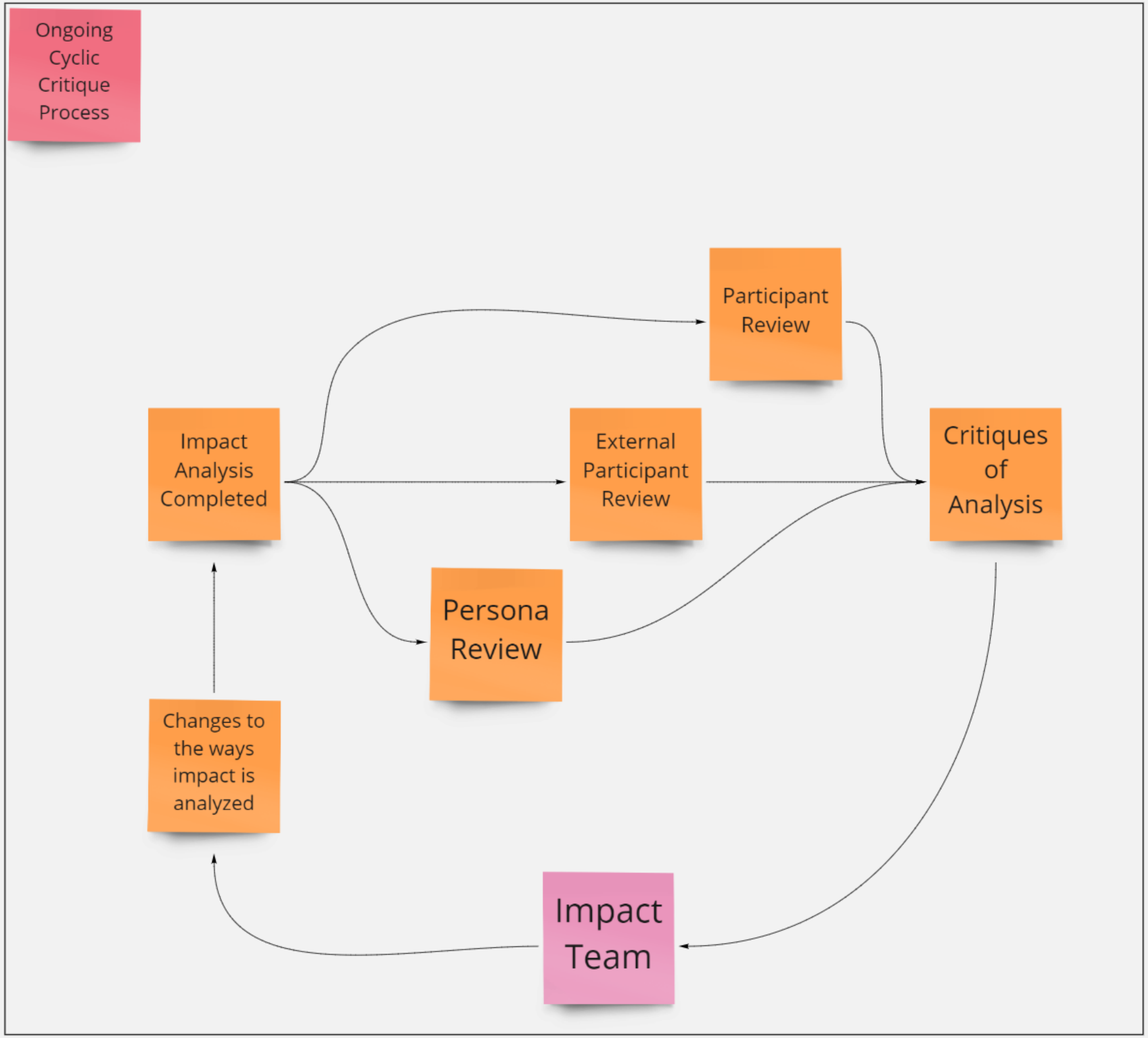
Assessments tools

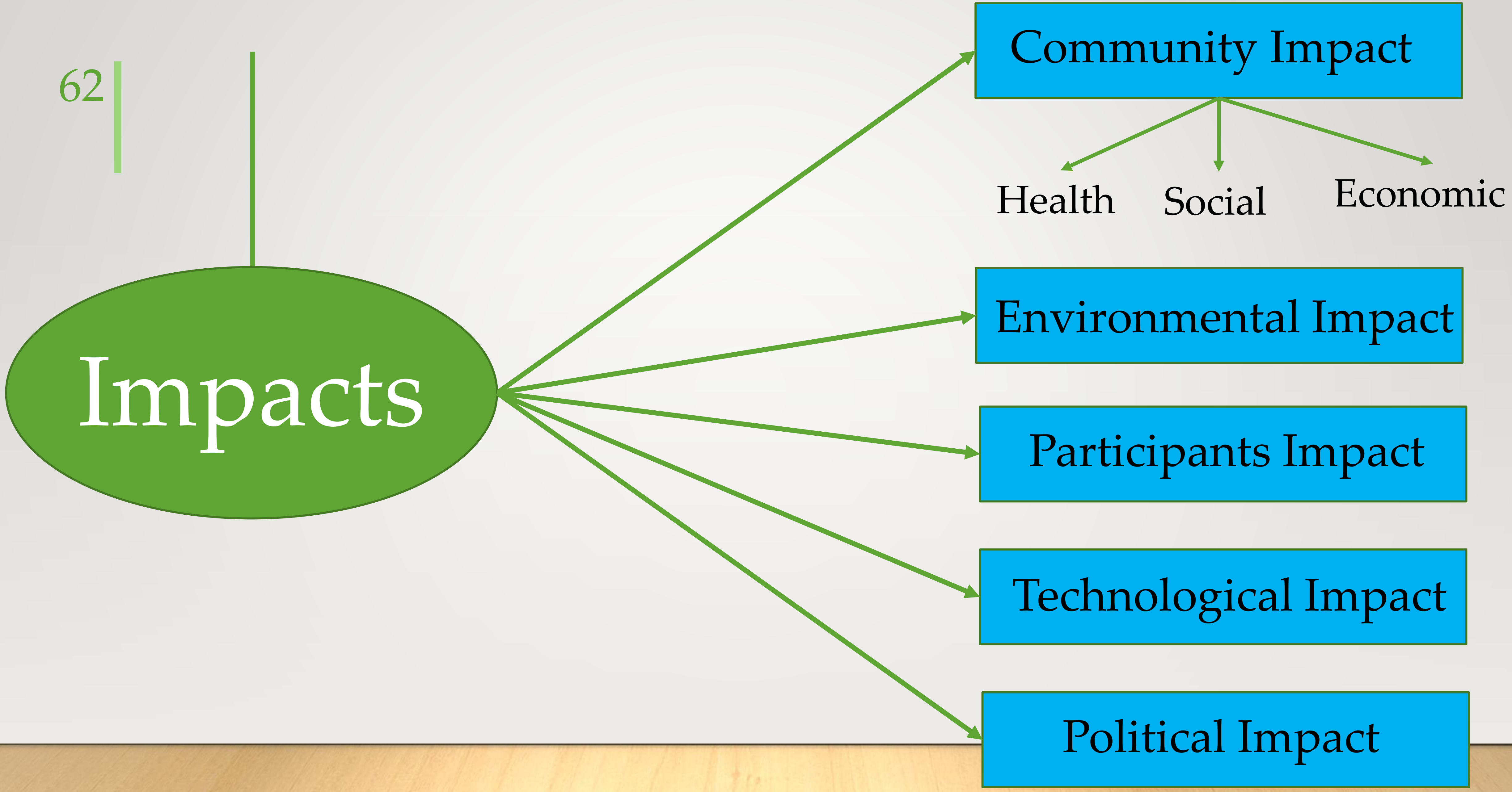
Summarizing the results

Critique Process

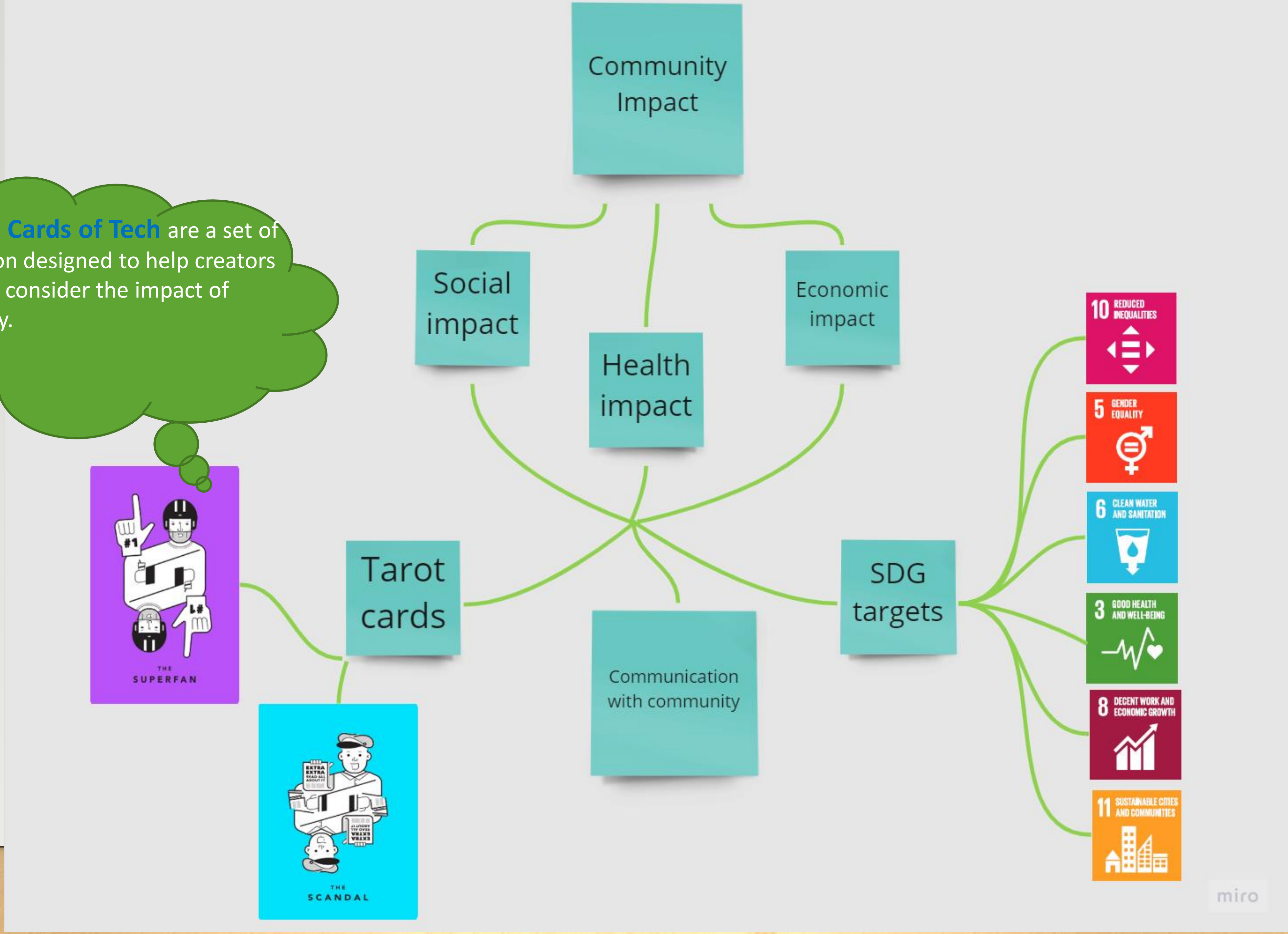


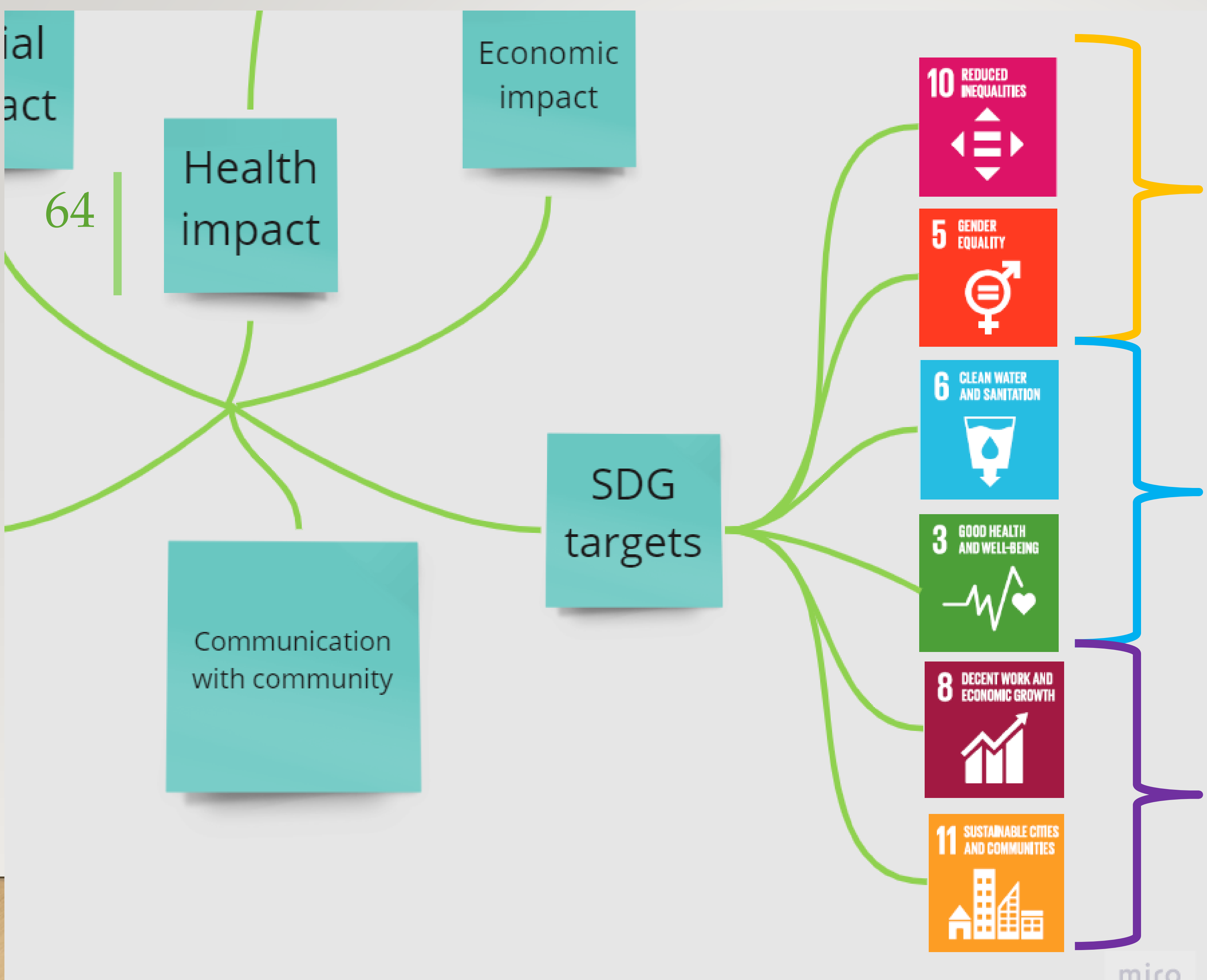
Critique Process




Impacts
Community Impact
Health
Social
Economic
Environmental Impact
Participants Impact
Technological Impact
Political Impact

The **Tarot Cards of Tech** are a set of provocation designed to help creators more fully consider the impact of technology.

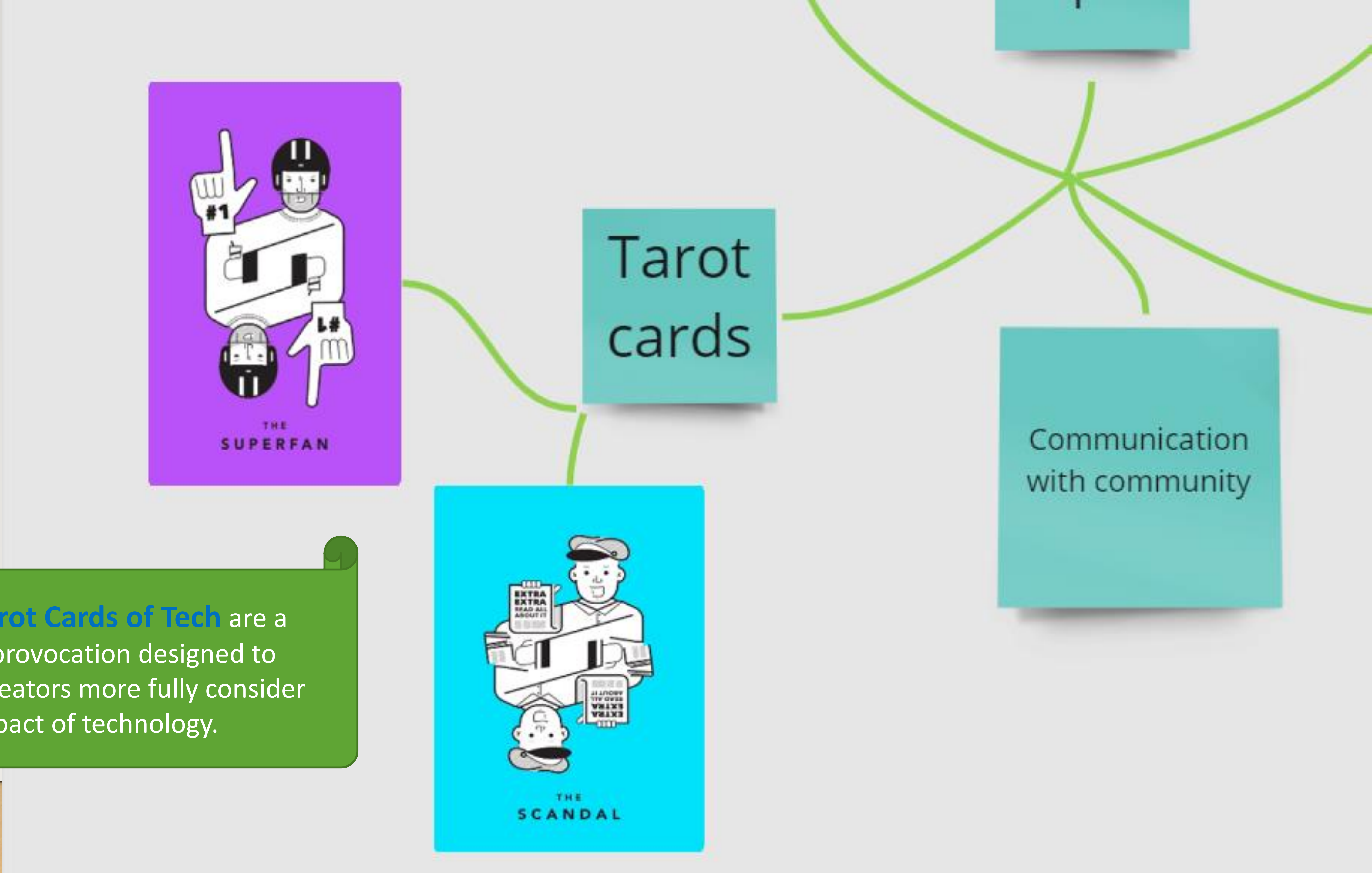




Social impacts

Health impacts

Economic impacts



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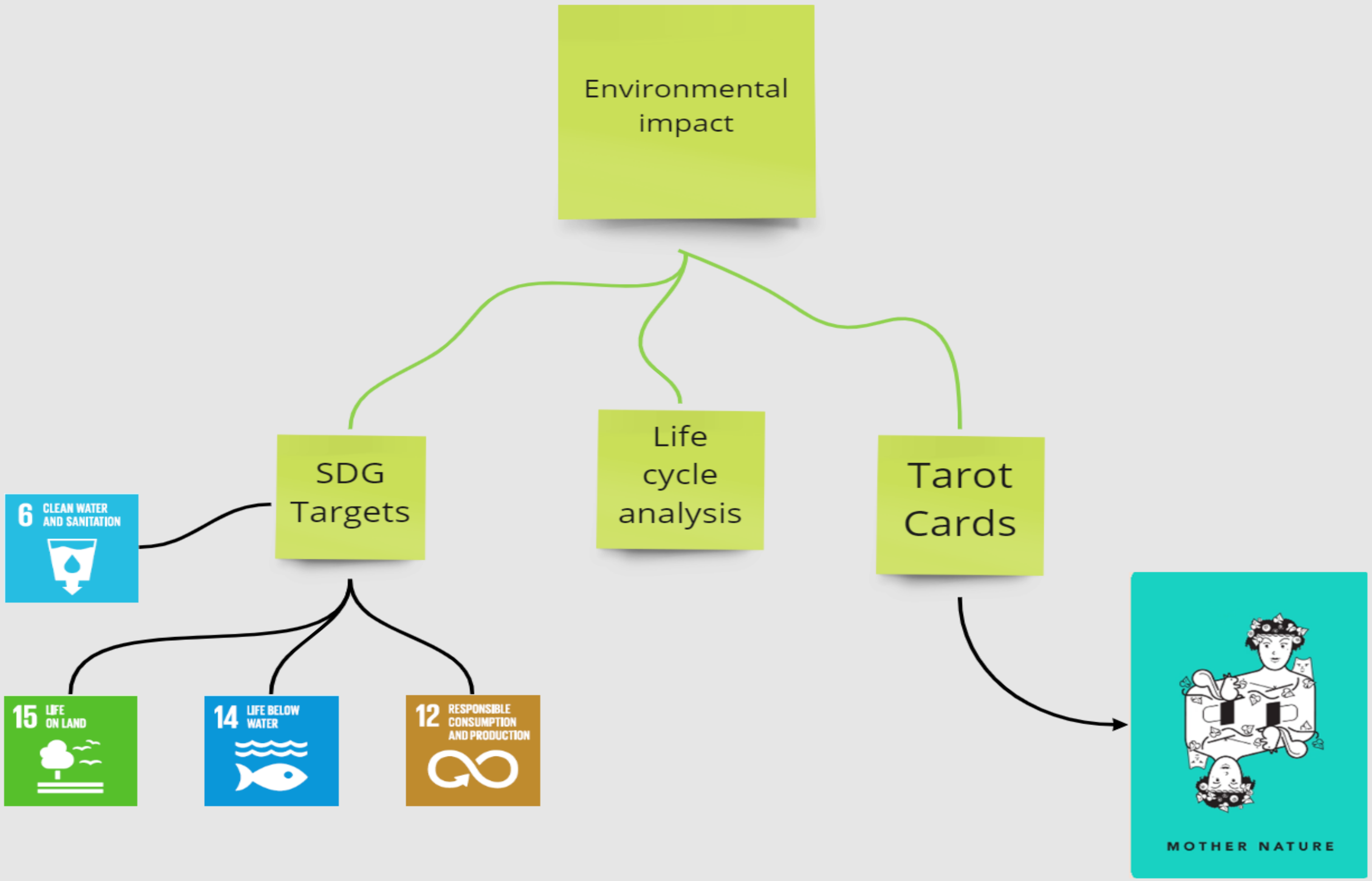
Environmental impact
SDG Targets
Life cycle analysis
Tarot Cards
6 CLEAN WATER AND SANITATION
15 LIFE ON LAND
14 LIFE BELOW WATER
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
MOTHER NATURE

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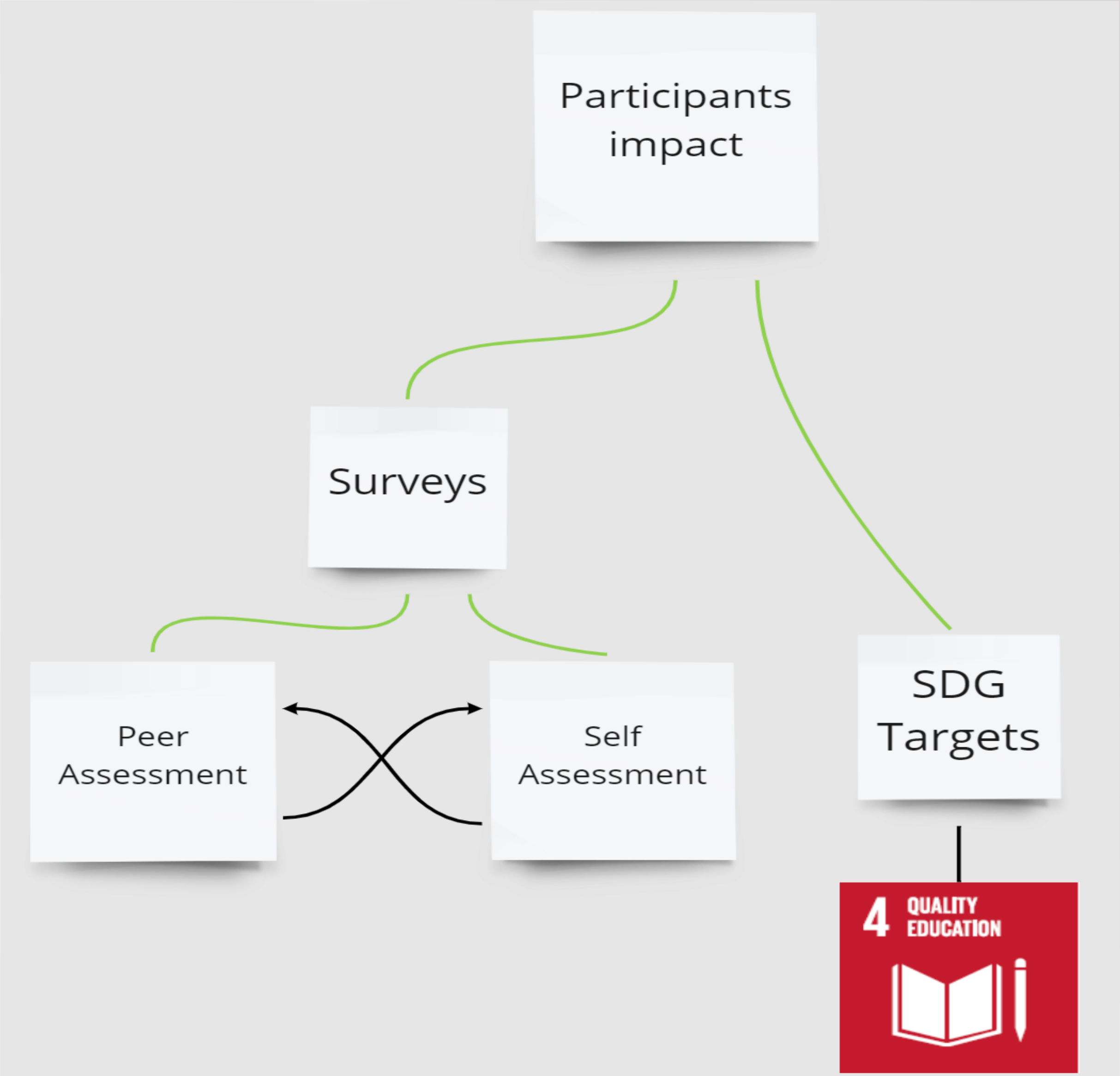
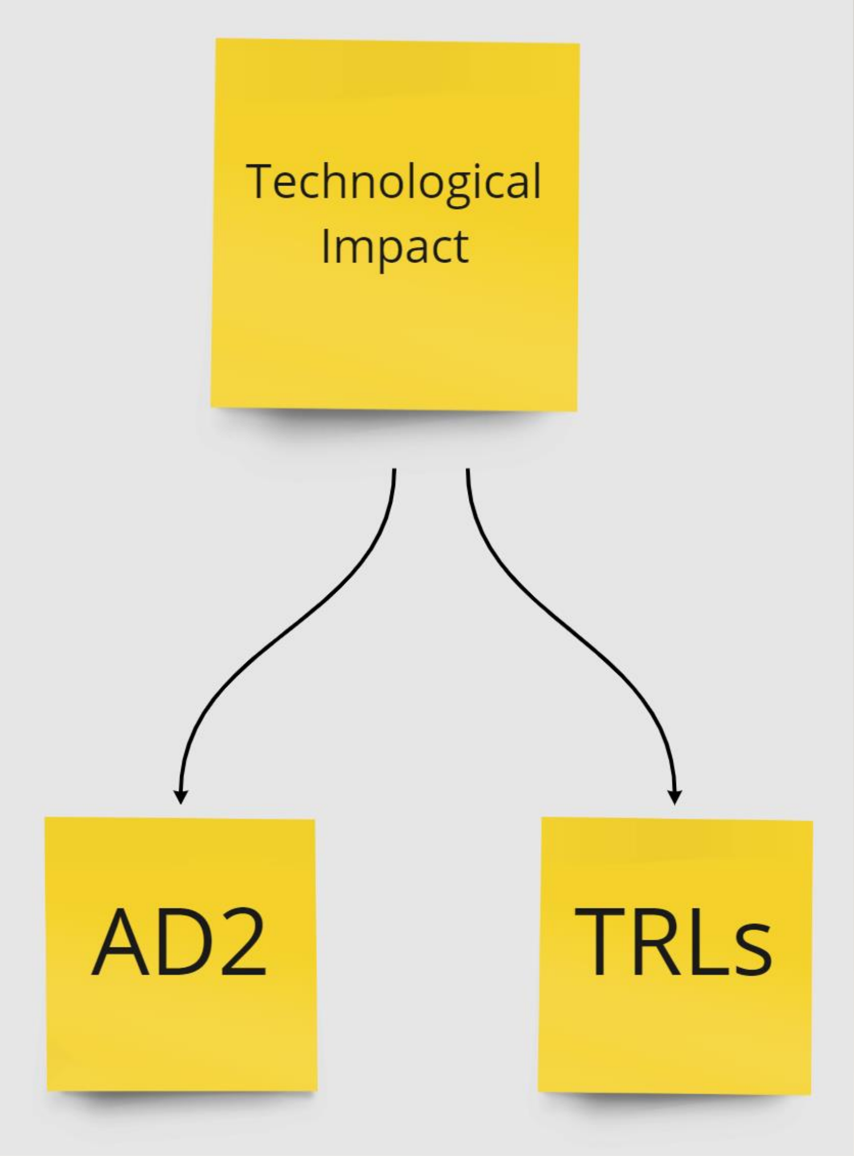
Participants impact



Technological impact

why do we need to assess the technological impact ?



Assessment tools

1- **Technology Readiness Levels (TRLs)**

TRL 9
- Actual system "flight proven" through successful mission operations

TRL 8
- Actual system completed and "flight qualified" through test and demonstration (ground or space)

TRL 7
- System prototype demonstration in a space environment

TRL 6
- System/subsystem model or prototype demonstration in a relevant environment (ground or space)

TRL 5
- Component and/or breadboard validation in relevant environment

TRL 4
- Component and/or breadboard validation in laboratory environment

TRL 3
- Analytical and experimental critical function and/or characteristic proof-of-concept

TRL 2
- Technology concept and/or application formulated

TRL 1
- Basic principles observed and reported

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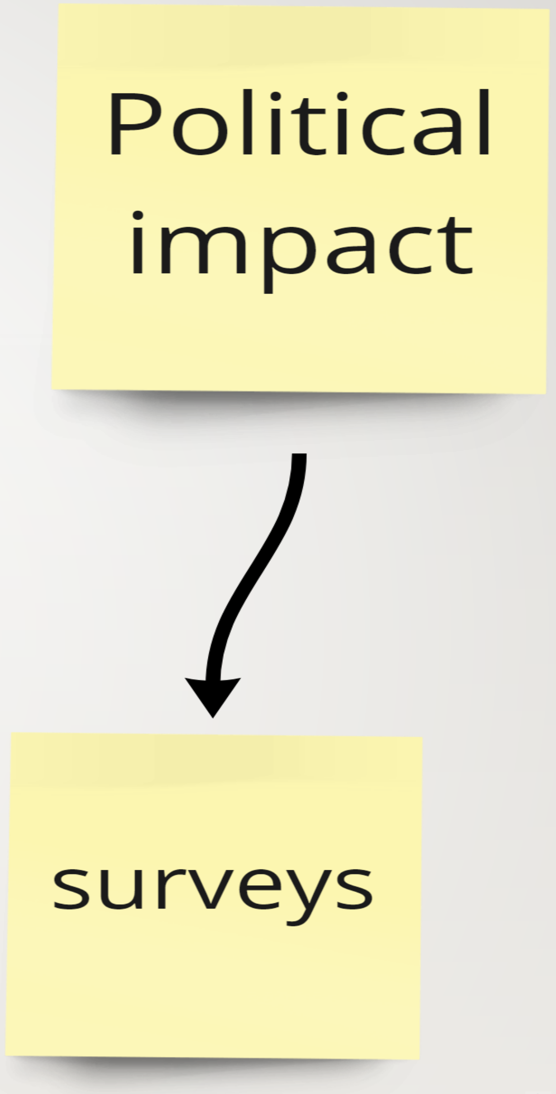
2- Advancement Degree of Difficulty (AD2)

Degree of Difficulty	Development Risk	Criteria
9	100%	Requires new development outside of any existing experience base. No viable approaches exist that can be pursued with any degree of confidence. Basic rersearch in key areas needed before feasible approaches can be defined.
8	80%	Requires new development where similarity to existing experience base can be defined only in the broadest sense. Multiple development routes must be pursued.
7	60%	Requires new development but similarity to existing experience is sufficient to warrant comparison in only a subset of critical areas. Multiple development routes must be pursued.
6	50%	Requires new development but similarity to existing experience is sufficient to warrant comparison in only a subset of critical areas. Dual development approaches should be pursued in order to achieve a moderate degree of confidence for success. (Desired performance can be achieved in subsequent block upgrades with a high degree of confidence.)
5	40%	Requires new development but similarity to existing experience is sufficient to warrant comparison in all critical areas. Dual development approaches should be pursued to provide a high degree of confidence for success.
4	30%	Requires new development but similarity to existing experience is sufficient to warrant comparison across the board. A single development approach can be taken with a high degree of confidence for success.
3	20%	Requires new development well within the experience base. A single development approach is adequate.
2	10%	Exists but requires major modifications. A single development approach is adequate.
1	0%	Exists with no or only minor modifications being required. A single development approach is adequate.

Political impact



Impact requirements

1- The Communities shall determine the desired goals and intended outcomes of the mission.

2-The Design Team shall be the deciding factor on what is feasible for the mission scope.

3- The Design Team shall reflect on their own bias and assumptions about the desires of the Communities.

4- proper compensation for community members.

5- The Design Team shall ensure that any work done within the Community is performed by members of the community

6- The Design Team shall provide educational communications to the general public regarding the mission and the crisis we are responding to.

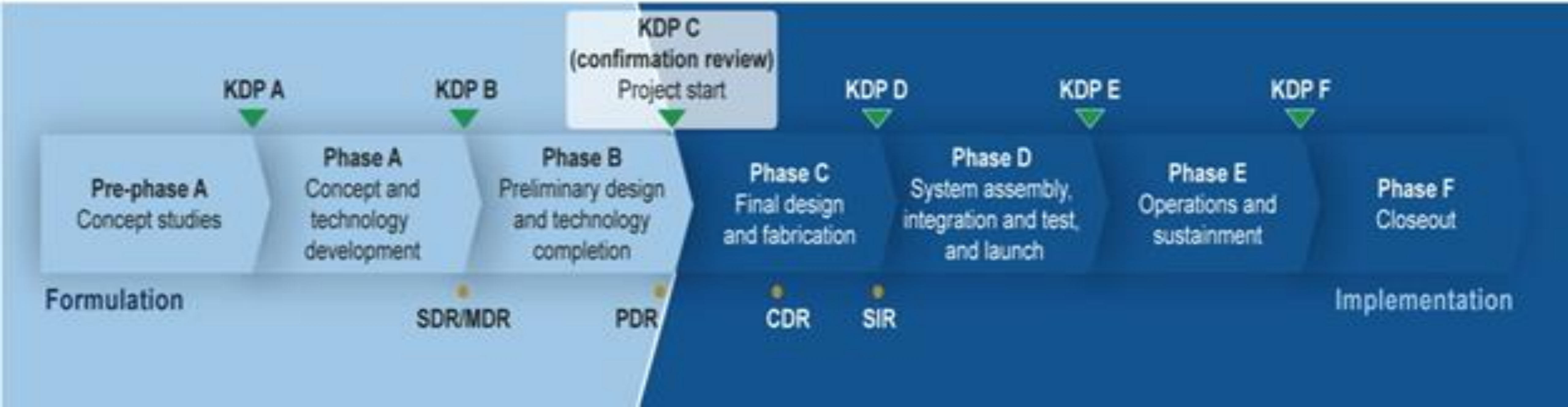
To get link to Miro board for communication team click here

Questions so far?

Mission Design

Phases of the mission

- Phase 0
- Phase A
- Phase B
- Phase C & D
- Phase E & F



Concept of operations

We would like to assert that CONOPS is last year team's effort

The CEUWM mission will have the usual phases of operation expected for a CubeSat, namely Launch and Early Operations (LEOP) / Commissioning, routine operations and end-of-life disposal activities.

Concept of Operations: Water Quality

- First, LEOP:-

In LEOP, the spacecraft will separate from the launch vehicle/space station, first power on, deploy antennas, and await first contact with a ground station. It will then go through systems checkout to ensure communications and power systems are functioning as expected.

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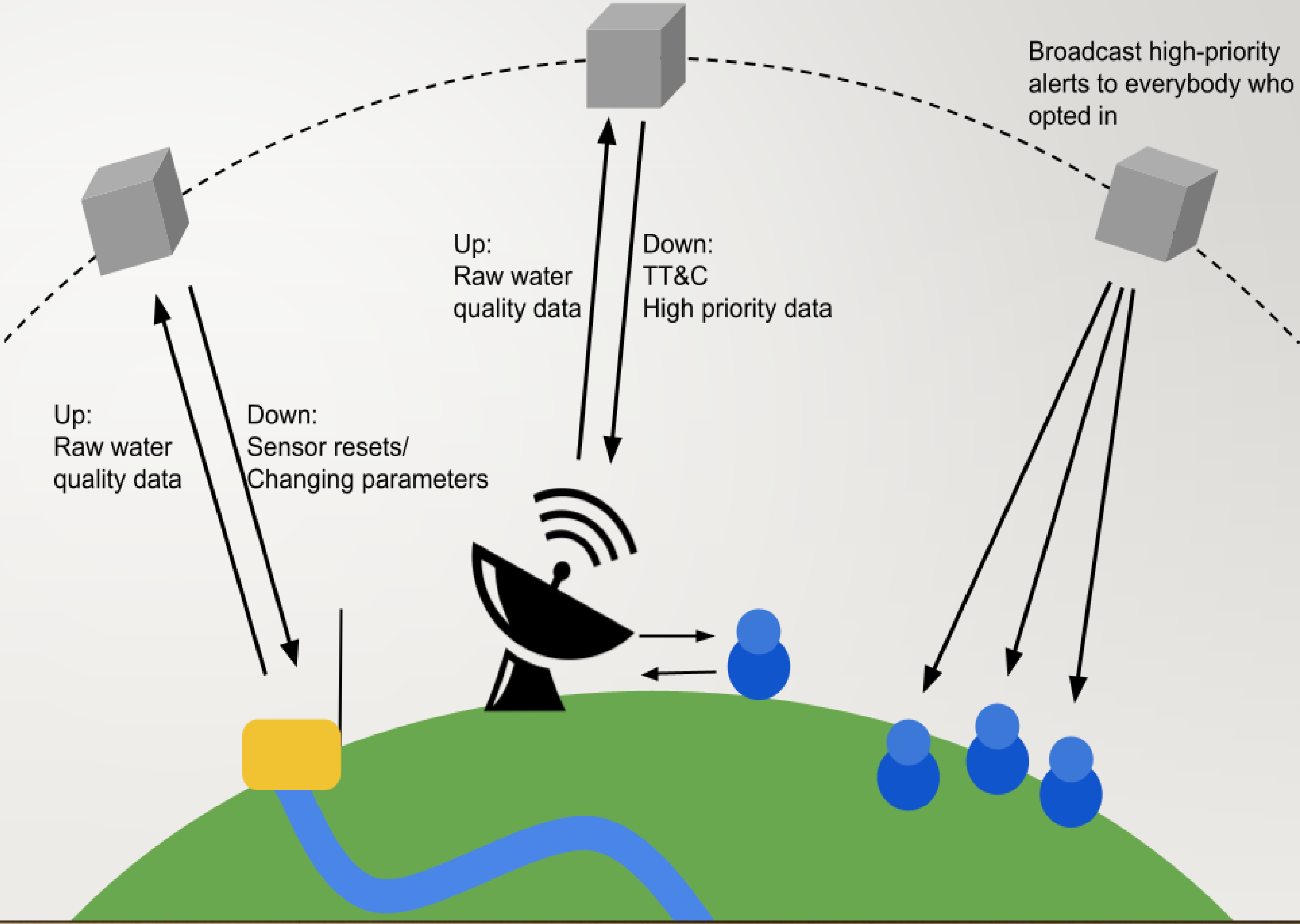
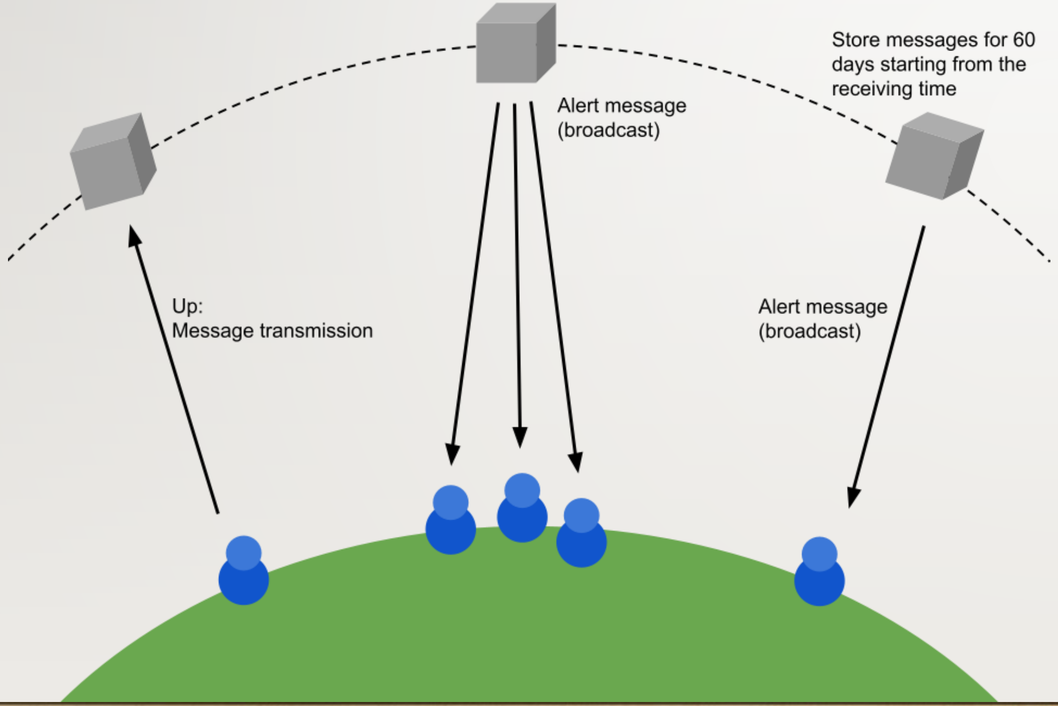
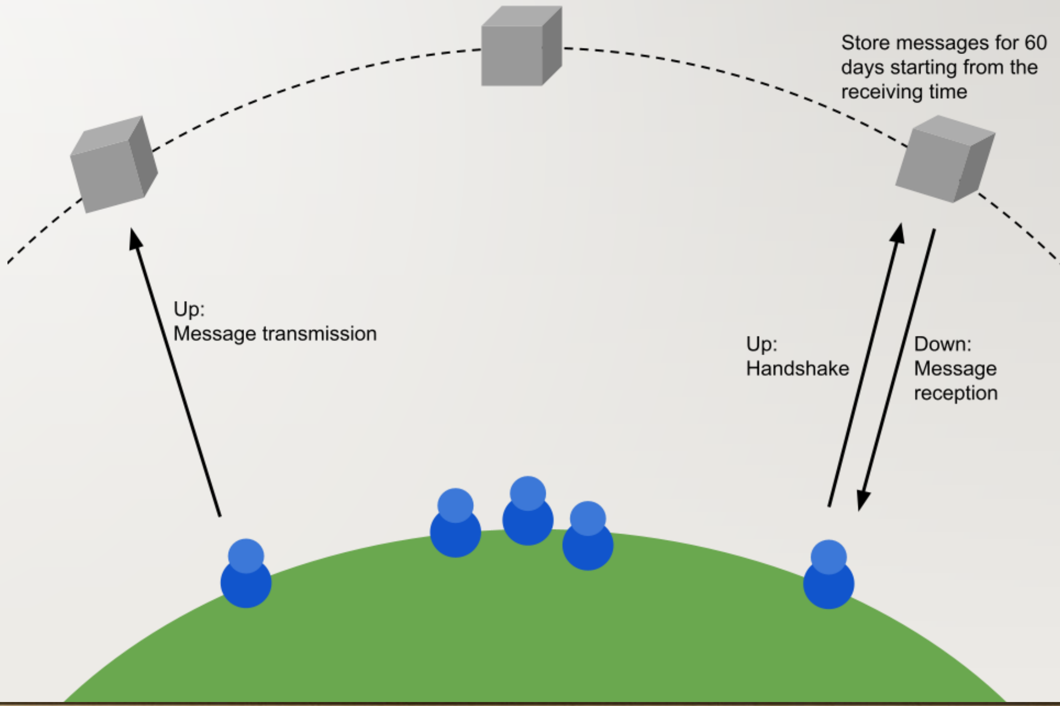
In routine operations, there will be three primary modes of operation:

- spacecraft monitoring and control
- water sensor data collection and dissemination *(spreading information widely)*
- SMS-like message collection and dissemination.



Concept of Operations: SMS





Mission Requirements

- Regional Water Quality Data for Northern Canadian and Uganda Communities.
- Sensor Information over 24H
- Alert Community Members
- Simple Messaging Service
- Configurable Data Reporting
- Joint Community Operations

Get the link to the requirements from here

		Top-Level Mission Requirements		
Requirement type	Requirement ID	Description of Requirement	Justification of Requirement	Verification of Requirement
Functional	REQM-MFUN-0000	The mission shall provide regional water quality data to predominantly indigenous communities in northern Canada over the expected mission lifetime.	The primary goal of this mission is to provide regional water quality data to indigenous communities in canada. Historically, northern canadian communities have had to ensure worse water quality than other Canadian communities, and may be less empowered in discussions about water quality than	At the design phase, this will be verified by ensuring the design permits water quality data provision to end-users. At the ground segment unit testing, this will be verified through configuration tests. At the end-to-end testing, this shall be verified by ensuring satellite provides the data throughout the
Functional	REQM-MFUN-0001	As a sub-goal of the main mission objective, the mission shall provide water quality data to Uganda communities in need of the same functionality but it will be on a less frequent basis.	The rotation of the satellite is idle most of it's time so if we can use the satellite by increasing it's duty cycle	At the design phase, this will be verified by ensuring the design permits water quality data provision to end-users. At the ground segment unit testing, this will be verified through configuration tests. At the end-to-end testing, this shall be verified by ensuring satellite provides the data throughout the
Functional	REQM-MFUN-0011	The mission shall provide an SMS based alert system to northern Canadian and Uganda communities	The secondary goal of this mission is to allow the transmission and reception of short messages between two or more parties, as well as alerts sent to multiple people at once.	This requirement will be verified during flight time by sending and receiving test SMS. During flatsat and unit tests, the hardware is tested.
Functional	REQM-MFUN-0002	The routine water quality data shall be provided as periodic reports with support of reporting different levels of detail on water quality for the northern canadian communities, which contain the levels of contaminants and overall quality at intervals conforming to the community members typical daily routine. As for Uganda there will	We want to allow the communities to control everything we possibly can, putting as few restrictions on the customization capabilities they have	At the design phase, this will be verified by ensuring the design permits end-user configurability of water quality reports. At the ground segment unit testing, this will be verified through configuration tests. At the end-to-end testing, this shall be verified by ensuring reports are generated periodically during the system test and by changing the
Functional	REQM-MFUN-0006	The mission shall have a timeline such that launch is within three (3) years of program kickoff	The proposed design is expected to be stable for three years (the mission	Progress will be tracked throughout design to ensure we are on-schedule
Functional	REQM-MFUN-0007	The mission implementation team shall work with the communities during mission operational lifetime to ensure defining a path to continued service after EOL as	The community/communities is/are given a significant role in this mission	The end-of-life plan will be co-created with members of the community and they will verify that they are aware of the plan.

Satellite Requirements

Requirement type	Requirement ID	Description of Requirement	Justification of Requirement	Verification of Requirement
Functional	REQM-SFUN-0011	The satellite shall de-orbit within a maximum of four (4) years.	The proposed design needs to be stable for three years (the mission repeats every four years).	Lifetime will be tested through simulated testing during the design phase
Functional	REQM-SFUN-0020	The satellite shall collect water quality data from all sensors within areas of interest over the course of 24 hrs	This ensures high coverage and frequent updates on the quality of water in affected areas.	This requirement will be verified through models and analyses of orbit coverage during the design phase
Functional	REQM-SFUN-0022	The satellite shall turn off non-essential systems when not in scope of Canada or Uganda communities, those that we are concerned about this year	As the systems are only servicing a specific area of the planet that only makes up a small part of the orbit, non-essential systems will be turned off to preserve power	The satellite's position in orbit will be simulated and the satellite's behavior will be determined and verified. The ability to switch into a low power mode will be tested during the unit test and flat sat phases. (positioning will be using reaction wheels or magnetorqurs)
Functional	REQM-SFUN-0040	The satellite shall store high and low priority messages until downlink	The SMS messages will only be transmitted to the area that pertains to the message contents. Messages will be stored until a pass over said area.	Communication with a ground station will be simulated and the satellite's behaviour will be determined and verified. The storage of data will be tested during the flatsat phase, and the downlink capability will be tested in the end to
Performance	REQM-SPER-0000	The satellite shall have a total mass of 1.1 kg which includes a margin of 20%	Each 1U CubeSat unit typically has a mass of 1kg. The req. is based on this assumption and the first iteration of the mass budget the CubeSat.	At the design phase, this will be verified by ensuring the primary structure has an allowable mass of well over 1.1 kg. This will be verified during the unit test by ensuring individual component masses fall under the design allowable limit. During Flat Sat by weighing the
Performance	REQM-SPER-0010	The spacecraft power consumption shall support a minimum orbital average payload operation of 2.2297W and peak payload operation of 3.92W ,taking into account the increase in power budget in order to cover Uganda as a sub goal	This is based on the computed maximum power required for the mission with margin of 20%	At the design phase this will be verified by ensuring that the components are selected conservatively. Power draw shall be measured for verification through the Flat Sat model by running repeated expected satellite duty cycles
Performance	REQM-SPER-0020	The satellite shall have an onboard data storage capacity for water quality report data for 7 days maximum and also for SMS message data for 60 days.	Based on the computed data budget, on each orbit, satellite collects a minimum of storage for satellite allows storage for multiple orbits in cases where downlink is not possible every orbit.	At the design phase this will be verified by ensuring the hardware and software supports storage that is stated by the preliminary design. Storage size shall be measured for verification through the Flat Sat model by adding and removing dummy data corresponding to expected worst-case cycles. During End-to-End testing, the satellite
Performance	REQM-SPER-0022	The satellite shall collect a minimum of 4 and a maximum of 8 water quality measurements from each sensor per day depending on it's	The water bodies shall be under frequent monitoring in order to provide reliable data	
Performance	REQM-SPER-0040	The Ground sensor receiver station shall be able to communicate with up to 10 sensors simultaneously.	The uplink times for two or more sensors could overlap and the satellite shall be able to receive all of them in real-time	Mission design will stimulate through STK what the signal levels to the receiver would have to look like, check the design of communications to make sure it can pick up signals, and if it is dividing signals by time or frequency. In the unit test phase, it will test 10 signals and ensure the components can handle that. The flat Sat phase would have 10 sensors with different levels of padding to test that the space segment can pickup 10 signals being transmitted simultaneously. End-to-end testing would involve 10 sensors connected

Ground Segment Requirements

Requirement type	Requirement ID	Description of Requirement	Justification of Requirement	Verification of Requirement
Functional	REQM-GFUN-0000	Ground station units shall have a design lifetime of minimum four (4) years	Ground station should outlive the satellite, as it could prove useful for communities to have after the satellite end-of-life, as well as continued operation throughout the lifetime.	Manufacturer warranties of all ground station parts must surpass 4 years of in-situ lifetime, or else this will have to be verified by means of a physical model.
Functional	REQM-GFUN-0001	Water Sensor units will have a design lifetime of minimum four (4) years	Water sensors should outlive the satellite to ensure continued operation throughout and potentially after the satellite lifetime.	Manufacturer warranties of all water sensor parts must surpass 4 years of in-situ lifetime, or else this will have to be verified by means of a physical model.
Functional	REQM-GFUN-0002	SMS units will have a design lifetime of minimum four (4) years	SMS units should outlive the satellite to ensure continued operation throughout the satellite lifetime.	Manufacturer warranties of all SMS unit parts must surpass a 4 years lifetime of use, or else this will have to be verified by means of a physical model.
Functional	REQM-GFUN-0010	Ground station units shall downlink and process (Level 0 processing)raw water quality data from the satellite.	Having the ground station process the raw data transmitted by the satellite reduces the required processing and data storage load on the satellite itself and provides access to both raw and processed data to the communities in the event that either data type is desired.	This requirement will be verified through End-to-End testing by transmitting dummy water quality data from the satellite test model, whereupon the ground station unit will process and display the data for confirmation of successful test.
Functional	REQM-GFUN-0011	Ground station units shall process incoming raw water quality data into CSV format	CSV format makes it easy to view the contents of the file directly, as well as allows for easy input into a spreadsheet for configurable data reporting (and would use much lower data storage)	This requirement will be verified during End-to-End testing through simulated data packet transfer, and by receiving a dummy packet from the Satellite after initial launch.
Functional	REQM-GFUN-0013	Ground station units shall provide water quality trend data over configurable time intervals when requested	Systems will be set up to allow the data to be reported in a way that allows users to decide what time intervals they wish to view the data allowing them to view short or long-	This requirement will be verified during end-to-end testing by creating trend data over several intervals using dummy data that spans one year.
Functional	REQM-GFUN-0041	Ground station units shall only downlink satellite high priority data when the power state is limited (High priority data for instance is a must)	If the ground station is limited on power it may not be condusive to a long life if it downlinked data every possible time, so we'll put it into a power saving mode	During End-to-End testing, the power state of the ground station will be limited, then communication with the satellite will be simulated several times over the course of 24 hours to
Performance	REQM-GPER-0000	All ground based equipment shall send priority alerts to the community in case of equipment failure at earliest downlink opportunity	In case of sensor or station equipment failure, an alert will be sent to the communities affected by the failure as soon as possible so a replacement or fix can be performed before data is potentially lost	During unit test, planned component outages will occur and the system will be tested for its ability to recognize and create an alert in a timely manner. During End-to-End, the system will be tested for its ability to create and transmit an
Regulatory	REQM-GREG-0000	Ground station units shall communicate with the spacecraft on amateur band radio frequencies.	Amateur band only requires an amateur radio license to use, and as such is much easier for communities to get rather than commercial which would impose a much larger financial burden	This requirement will be verified through measuring antenna transmission and reception during unit test. During End-to-End, antenna units will transmit signals and those signals will be verified to be within the required amateur band.
Regulatory	REQM-GREG-0001	SMS units shall communicate with the spacecraft on amateur band radio frequencies.	SMS units have human operators and as such are allowed to transmit and receive on the Amateur band	This requirement will be verified through measuring antenna transmission and reception during unit test. During End-to-End, antenna units will transmit signals and those signals will be verified to be within the required amateur

Launch Options

Key drivers:

- launch availability
- launch cost
- orbit options that cover Northern Canada and Uganda

Key parameters:

- inclination, “local time of ascending node” for “sun-synchronous” orbits

Common Orbits

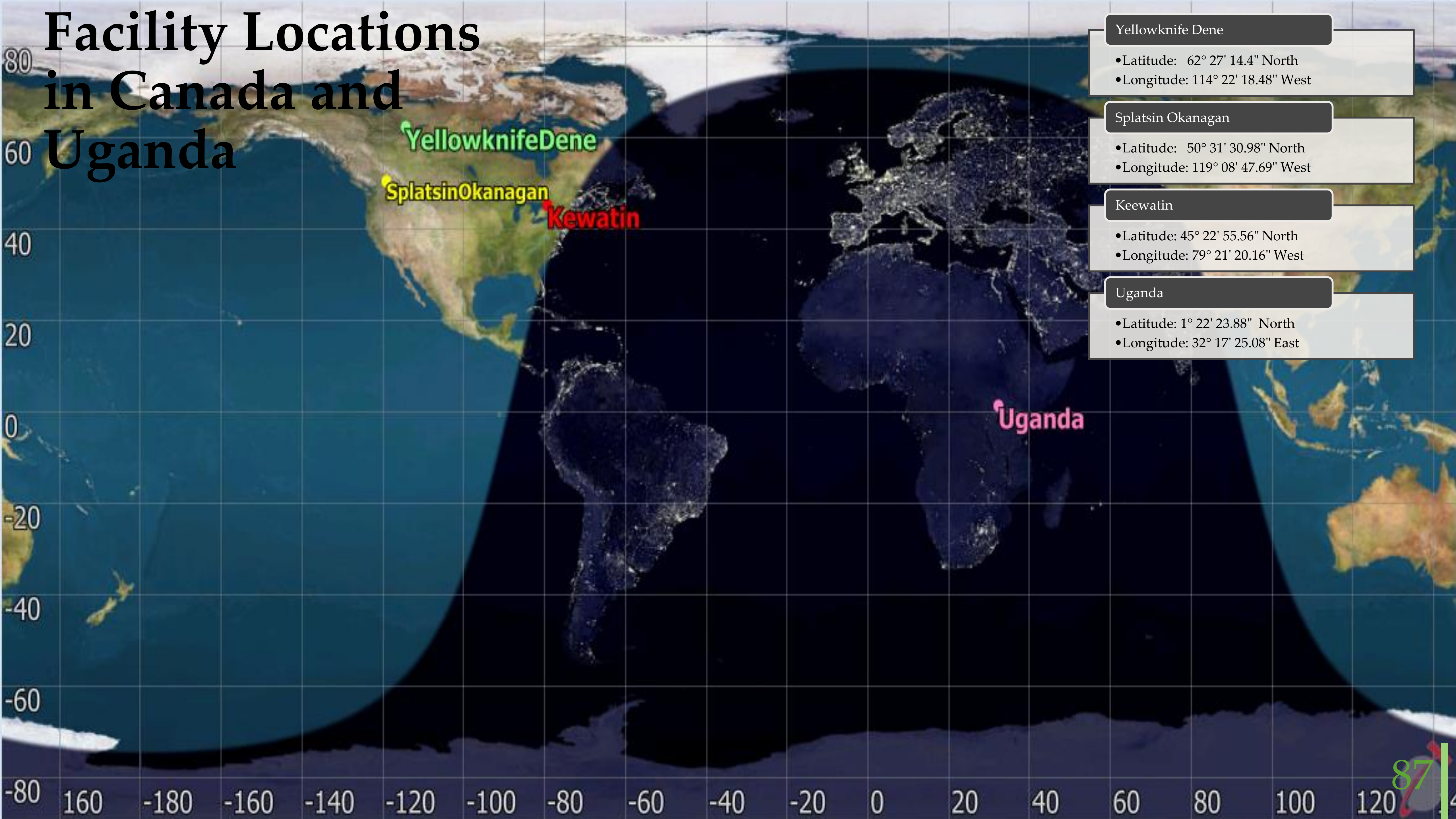
Sun Synchronous Orbit

- Inclination: 97.3087 degrees
- Altitude: 500 km

ISS Orbit

- Inclination: 51.64 degrees
- Altitude: 420 km

Facility Locations in Canada and Uganda



Yellowknife Dene

- Latitude: 62° 27' 14.4" North
- Longitude: 114° 22' 18.48" West

Splatsin Okanagan

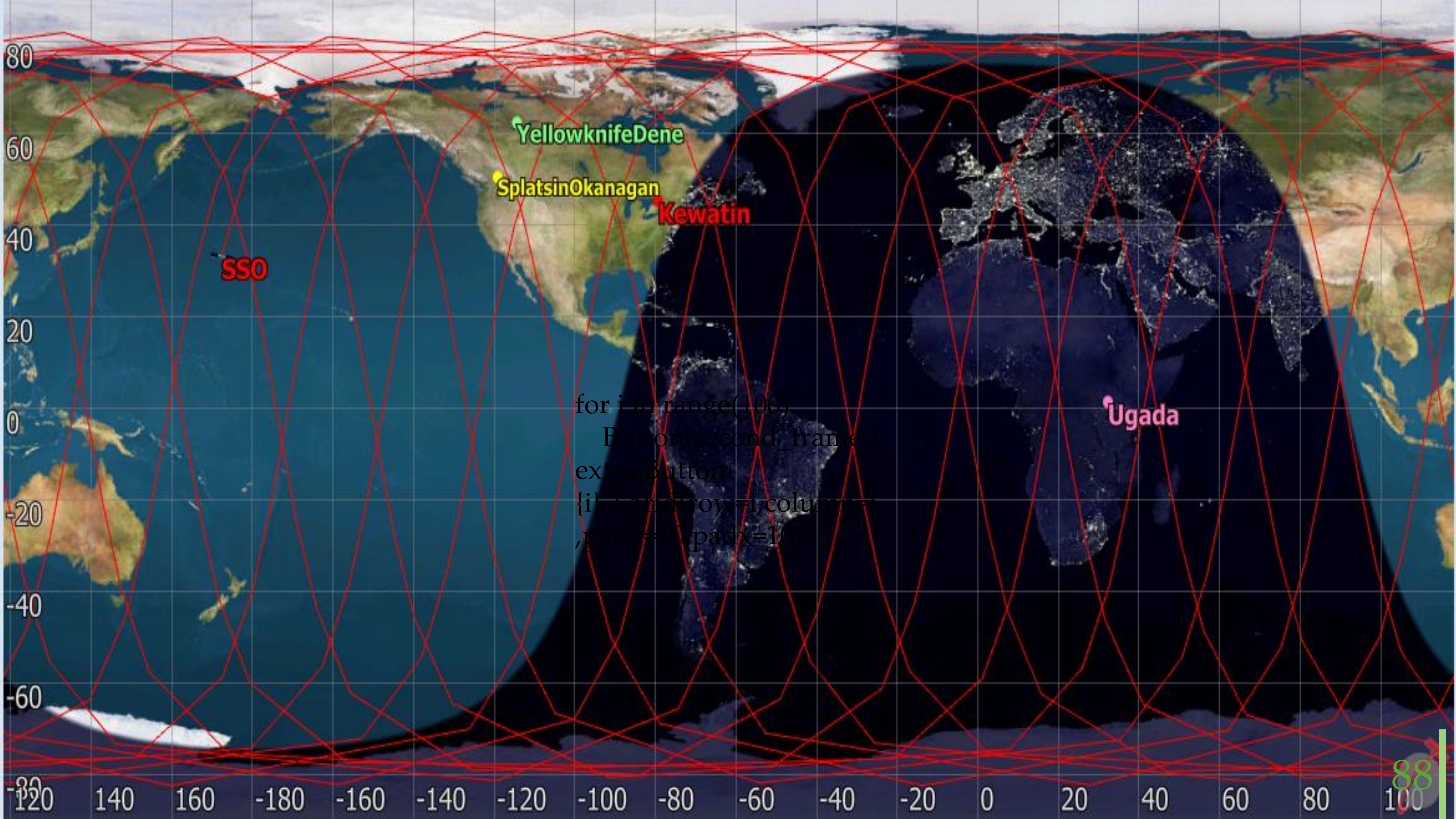
- Latitude: 50° 31' 30.98" North
- Longitude: 119° 08' 47.69" West

Keewatin

- Latitude: 45° 22' 55.56" North
- Longitude: 79° 21' 20.16" West

Uganda

- Latitude: 1° 22' 23.88" North
- Longitude: 32° 17' 25.08" East

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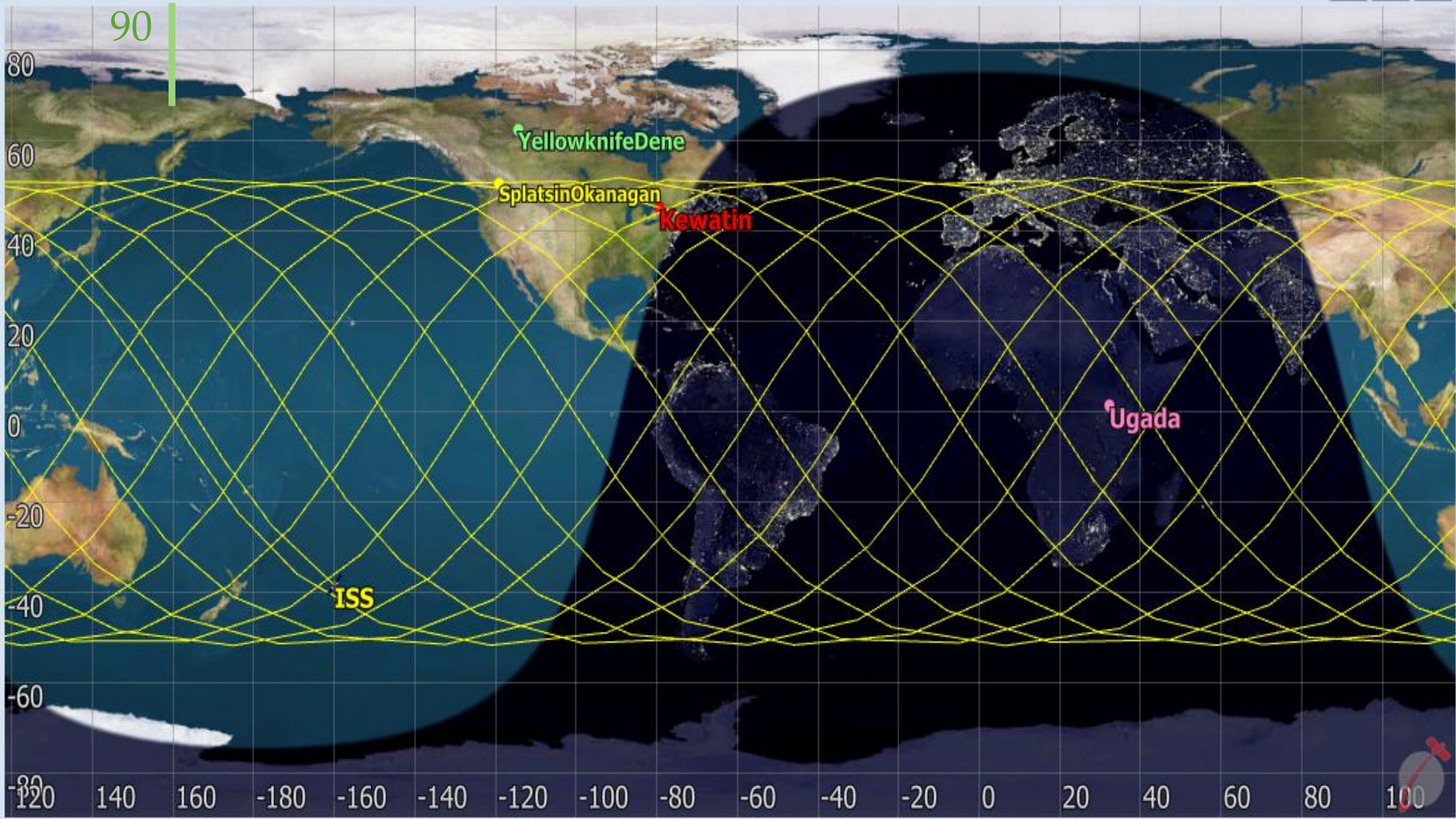
SSO observations for an elapsed day

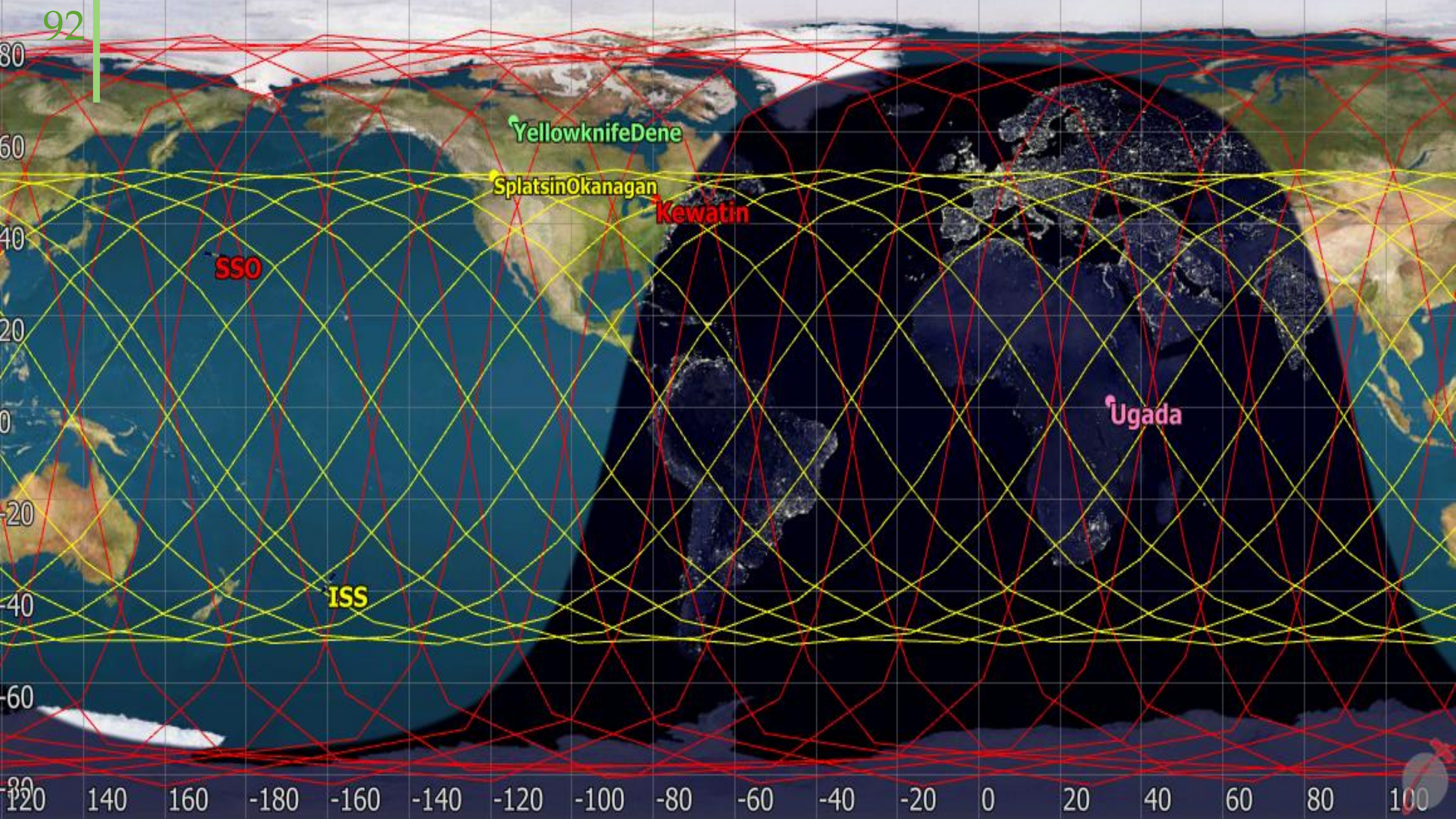
Ground Stations	Number of events	Average Daily Duration (s)
Keewatin	4	428.3039118
SplatsinOkanagan	5	362.99132
YellowknifeDene	8	343.67325
Uganda	4	322.26404



80
60
40
20
0
-20
-40
-60
-80
YellowknifeDene
SplatsinOkanagan
Kewatin
Ugada
ISS
120
140
160
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100

ISS observations for an elapsed day

Ground Stations	Number of events	Average Daily Duration (s)
Keewatin	6	355.7726
SplatsinOkanagan	5	413.1631
YellowknifeDene	3	244.1674
Uganda	4	316.8299


YellowknifeDene
SplatsinOkanagan
Kewatin
SSO
ISS
Ugada
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60
40
20
0
-20
-40
-60
120
140
160
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100

Trade studies

We choose based on :

1. Which has more encounters per day?
2. Compare the YellowknifeDene station encounters in northern Canada as a region of interest?
3. Concerning the power budget for both orbits.

Type of orbit	SSO	ISS
Altitude (Km)	500	420
Inclination (degrees)	97.380	51.64
Access times for all ground station in Canada per day	17	14
Access times for the ground station in Uganda per day	4	4

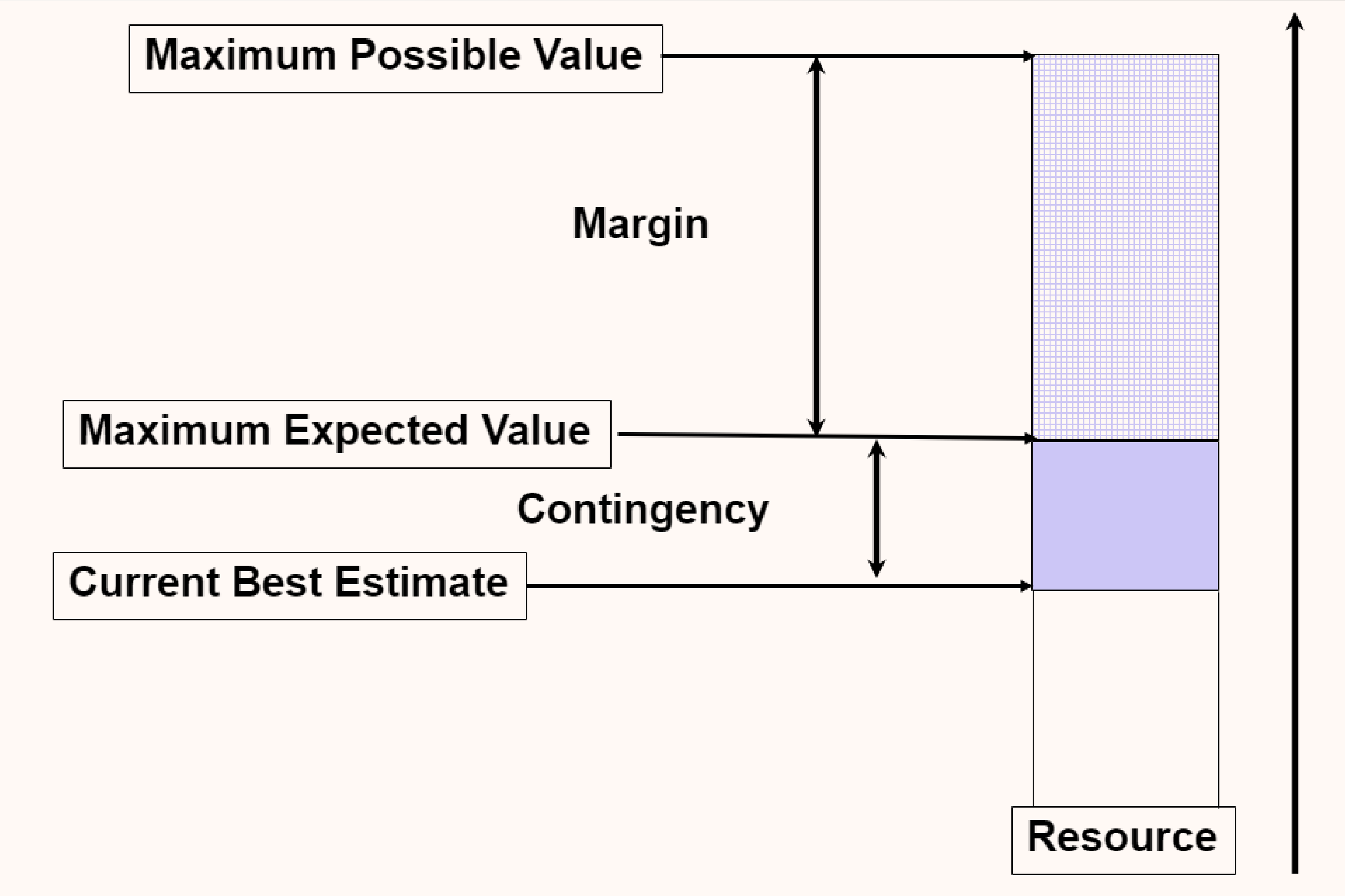
Launch Providers

Since we had some talks from Astreos company we can think of it as a launch provider and an insurer.

Astreos streamlines the CubeSats & nanosats operators' launch experience by taking care of every aspect of their mission, from insurance to transportation, to optimize their time and decrease their costs.

95 | Contingencies and Margins

Relevant for both engineering and financial budgets



Space Segment Power Expenditure

CubeSat

Based on last year's Data We understand that we haven't gone through the entire power consumption, but this is flagged for the next phase.

Component	Nominal Usage(W)+ Contingency Factoring in Duty Cycle	Contingency (%)	Duty Cycle (%)	Nominal Usage(W)	Peak Duty Cycle (%)	Peak Usage(W) + Contingency Factoring in Peak Duty Cycle
CubeSat						
OBC Endurosat	1.37W	5%	100%	1.3W	100%	1.37W
LoRa transceiver	0.162W	20%	30%	0.45W	100%	0.54W
Low-Noise Amplifier	0.18W	20%	30%	0.5W	100%	0.6W
UHF transceiver II	0.315W	5%	30%	1W	100%	1.05W
Total	2.027W			3.15W		3.56W
Margin	10%			10%		20%
Total+Margin	2.2297W			3.47W		3.92W

The data included in the spacecraft power use table was developed with the assumption that the mission will be making use of a sun-synchronous orbit.

Space Segment Power Generation

CubeSat

Component	Nominal Usage(W)+ Contingency Factoring in Duty Cycle	Contingency (%)	Duty Cycle (%)	Nominal Usage(W)	Worst case Duty Cycle (%)	Peak Usage(W)+ Contingency Factoring in Peak Duty Cycle
CubeSat						
EPS I Plus Electric Power System Endurosat	19.38 W	5%	100%	20.4 W	100%	19.38Wh
ISIS CubeSat solar panels complete Set	2.07 W	10%	100%	2.3 W	85%	1.7595W
Surplus Power (power generation-nominal usage)	-0.1597W			-1.17W*		-2.16**

* Nominal usage here is calculated using the nominal power expenditure featured on the previous slide (CubeSat power expenditure w/ contingencies and duty-cycles)

** Worst-case numbers were likewise calculated using the worst-case power expenditure numbers featured on the previous slide (w/ contingencies and duty-cycles)

Ground Segment Power Budget

Sensor Suite

Component	Nominal power draw (W)	Contingency (%)	Nominal duty cycle (%)	Peak power draw (W)	Peak Duty Cycle (%)	Total orbital average power draw (W)
Ground Sensors						
Arduino Edge Control	0.0001	20%	90%	5	10%	0.60
Arduino MKR WAN 1300 (LoRa connectivity) 915MHz	0.036	20%	70%	0.1	30%	0.07
DS18B20 Thermometer	0.024	20%	60%	0.033	40%	0.02
Arduino Conductivity Sensor	0.0234	30%	70%	0.045	30%	0.03
Turbidity Sensor	0.026	30%	80%	0.1	20%	0.08
Arduino Analog pH Sensor Kit	0.0585	30%	60%	0.075	40%	0.07
Ammonia Electrode Sensor	0.052	30%	90%	0.1	10%	0.06
Arduino Level of Water Sensor	0.0624	30%	90%	0.06	10%	0.07
Total	0.2824			5.513		0.99
Margin					20%	0.20
Total with margin						1.19

Life cycle cost

- The average temperature in Northern Canada is -22°: 20° C
- The average temperature in Lake Victoria is 8°: 48° C

- Regarding the life cycle cost, maintenance and replacement costs must be kept in mind.

Ground Sensors	Recommended Operating Temperature (°C)
Arduino Edge Control	-25°: 70°
Arduino MKR WAN 1300-915MHz	-25°: 70°
DS18B20 Thermometer	-10°: 85°
Arduino Conductivity Sensor	0°: 40°
Arduino Turbidity Sensor	5°: 90°
Arduino Analog pH Sensor Kit	0°: 50°
Ammonia Electrode Sensor	0°: 50°
Arduino Level of Water Sensor	10°: 30°

End of life Plan

- End of life of the satellite will be done by shutting down all devices in a predetermined manner until the satellite eventually falls in.
- The analyses of EOL phase still need to be done in the following phase.
- As for the ground segment it will be operational for a year after the decommissioning of the satellite in case, we need any data for experimental use for example.

Have the requirements answered our key questions?

- Do you think we have constituted a useful mission?
- Are our mission requirements complete?
- Have we discussed it appropriately?
- Do you have any comment about our work?

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Questions for the mission team

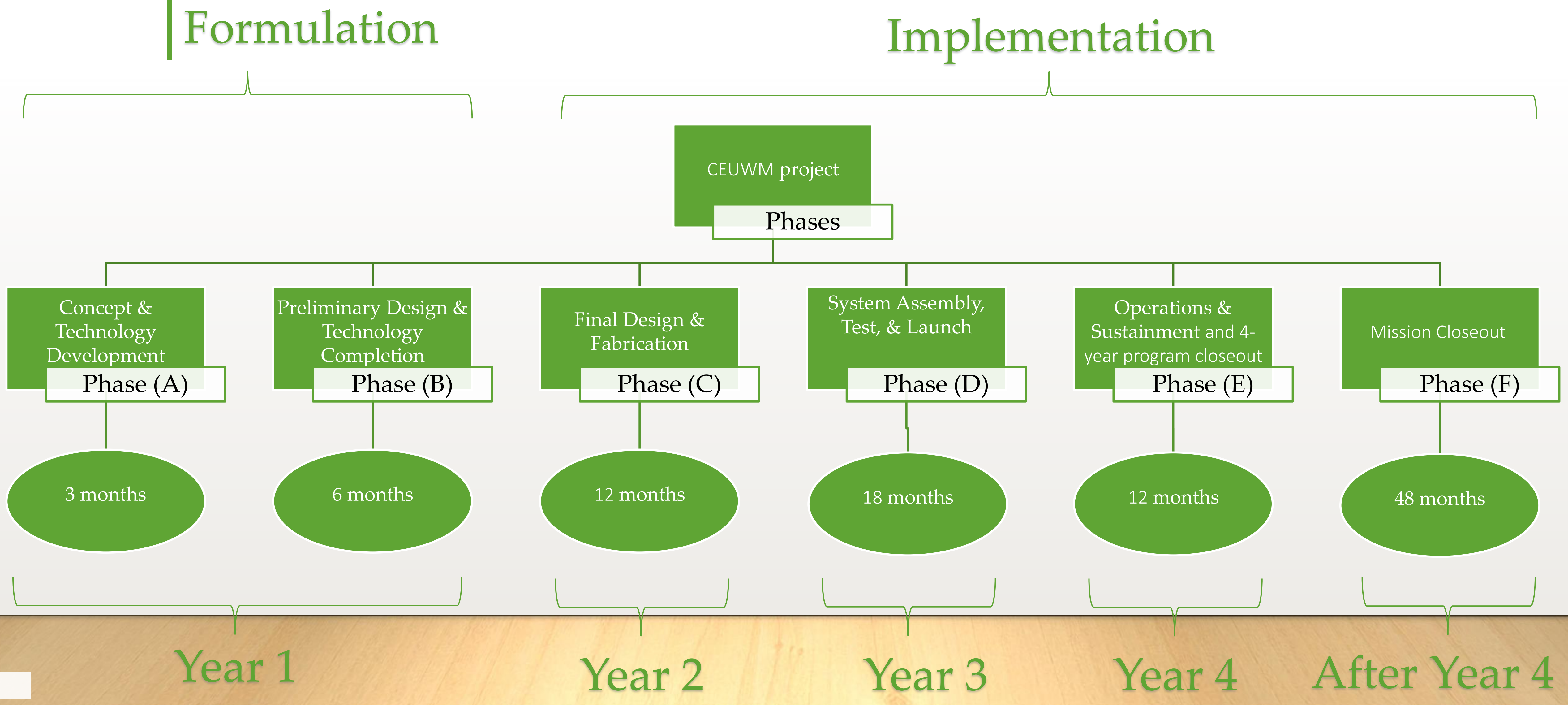
Please feel free to use the chat feature or unmute and ask your questions!

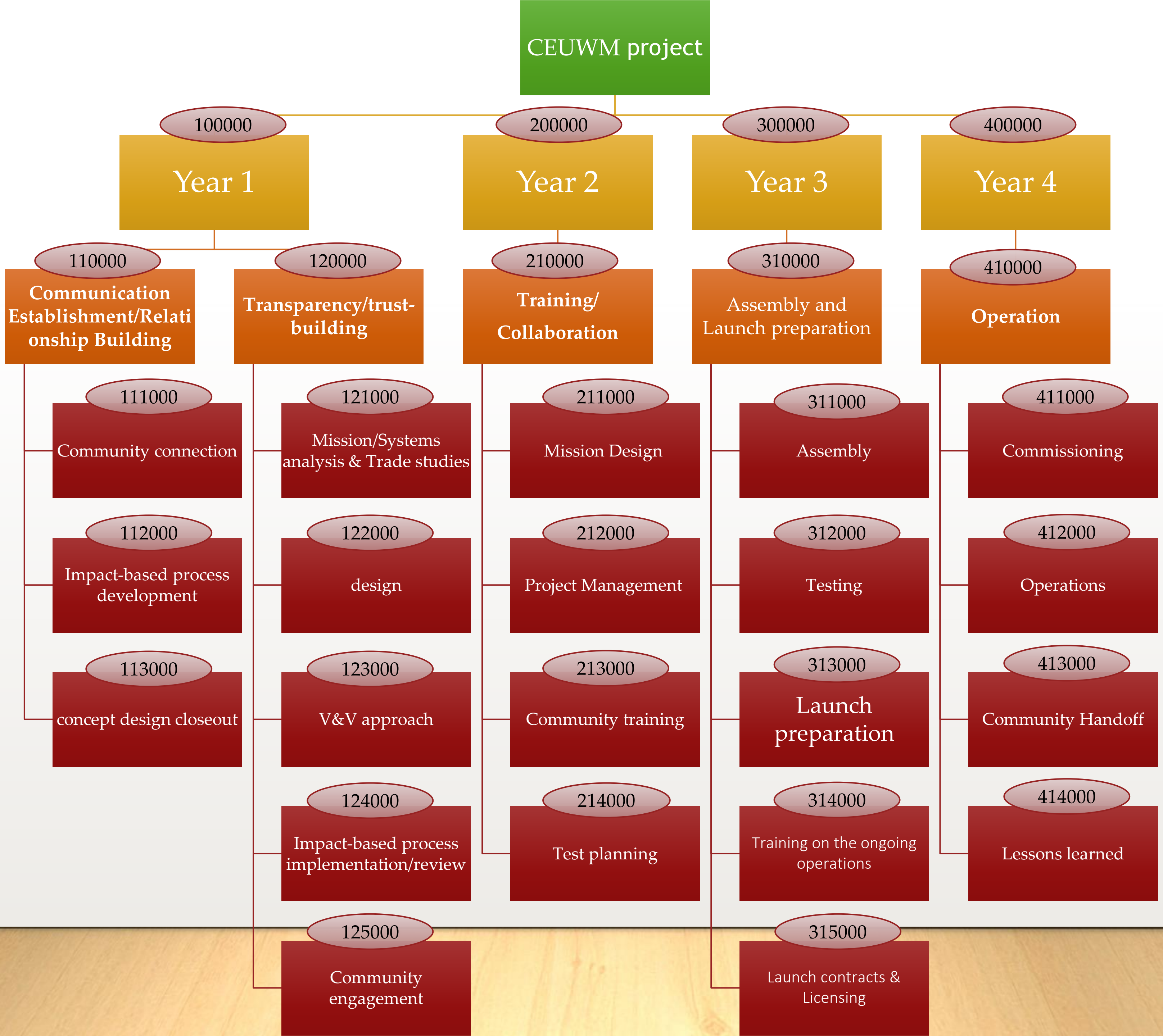
Program Management

Project Management Team Roles

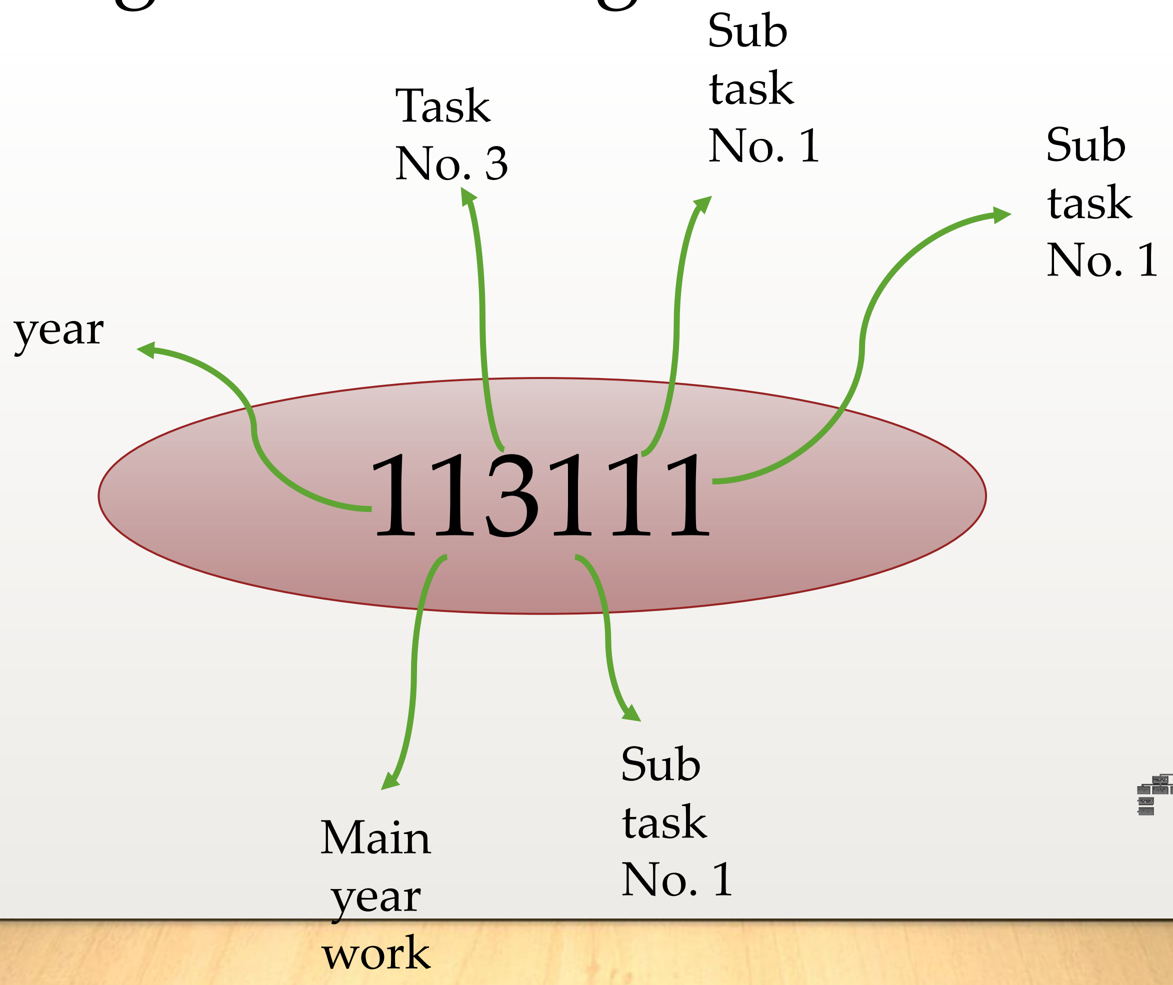
- Developing scheduled plan
- Developing WBS
- Ensuring on-time tasks completion

NASA mission phases

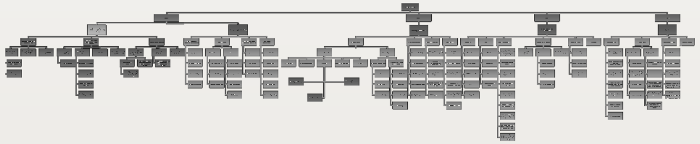


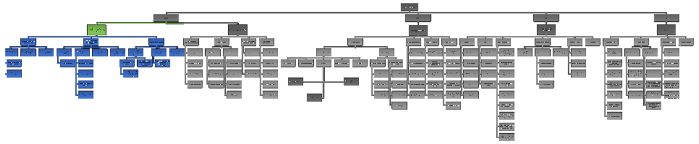

CEUWM project
100000
Year 1
200000
Year 2
300000
Year 3
400000
Year 4
110000
Communication Establishment/Relationship Building
120000
Transparency/trust-building
210000
Training/ Collaboration
310000
Assembly and Launch preparation
410000
Operation
111000
Community connection
112000
Impact-based process development
113000
concept design closeout
121000
Mission/Systems analysis & Trade studies
122000
design
123000
V&V approach
124000
Impact-based process implementation/review
125000
Community engagement
211000
Mission Design
212000
Project Management
213000
Community training
214000
Test planning
311000
Assembly
312000
Testing
313000
Launch preparation
314000
Training on the ongoing operations
315000
Launch contracts & Licensing
411000
Commissioning
412000
Operations
413000
Community Handoff
414000
Lessons learned

Work package numbering



WBS Chart mini-map

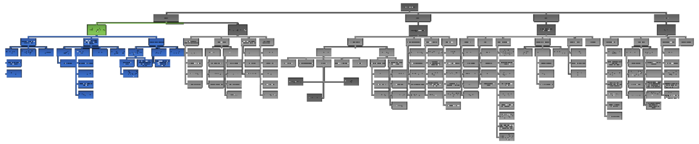




Phase (A)

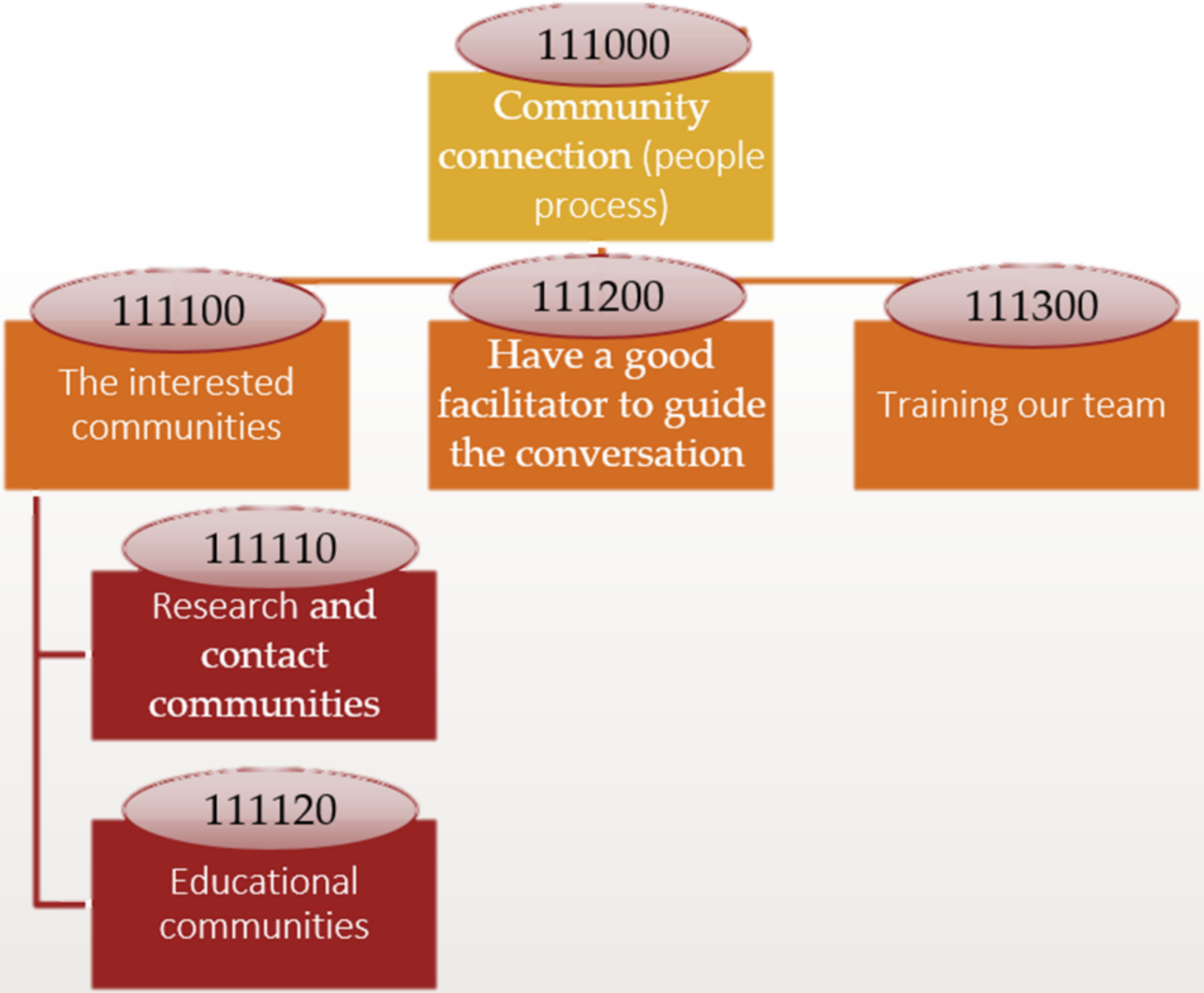
109

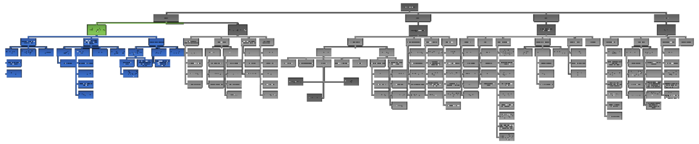
- 110000 Communication Establishment/Relationship Building
  - 111000 Community connection (people process)
    - 111100 The interested communities
      - 111110 Research and contact communities
      - 111120 Educational communities
    - 111200 Have a good facilitator to guide the conversation
    - 111300 Training our team
  - 112000 Impact-based process development (people process)
    - 112100 measuring & reporting SDG impact
      - 112110 Using SDG tool
    - 112200 Effective Decision Making
      - 112210 Identifying key problems
      - 112220 Determining priorities
      - 112230 analyzing alternative solutions
      - 112240 Selecting & Developing an action plan
    - 112300 Spacecraft performance
    - 112400 Ensure the spacecraft reentry at the end of life
  - 113000 concept design closeout
    - 113100 Lower TRL prototyping (product process)
      - 113110 Demonstration purposes
        - 113111 Ensure The community can reach the prototype to understand what we're doing
      - 113120 Help everybody on board with what the mission is trying to achieve
    - 113200 Country - based sensor finalisation
      - 113210 identifying the physical and environmental conditions in each country
    - 113300 Community Interface finalization



Phase (A)

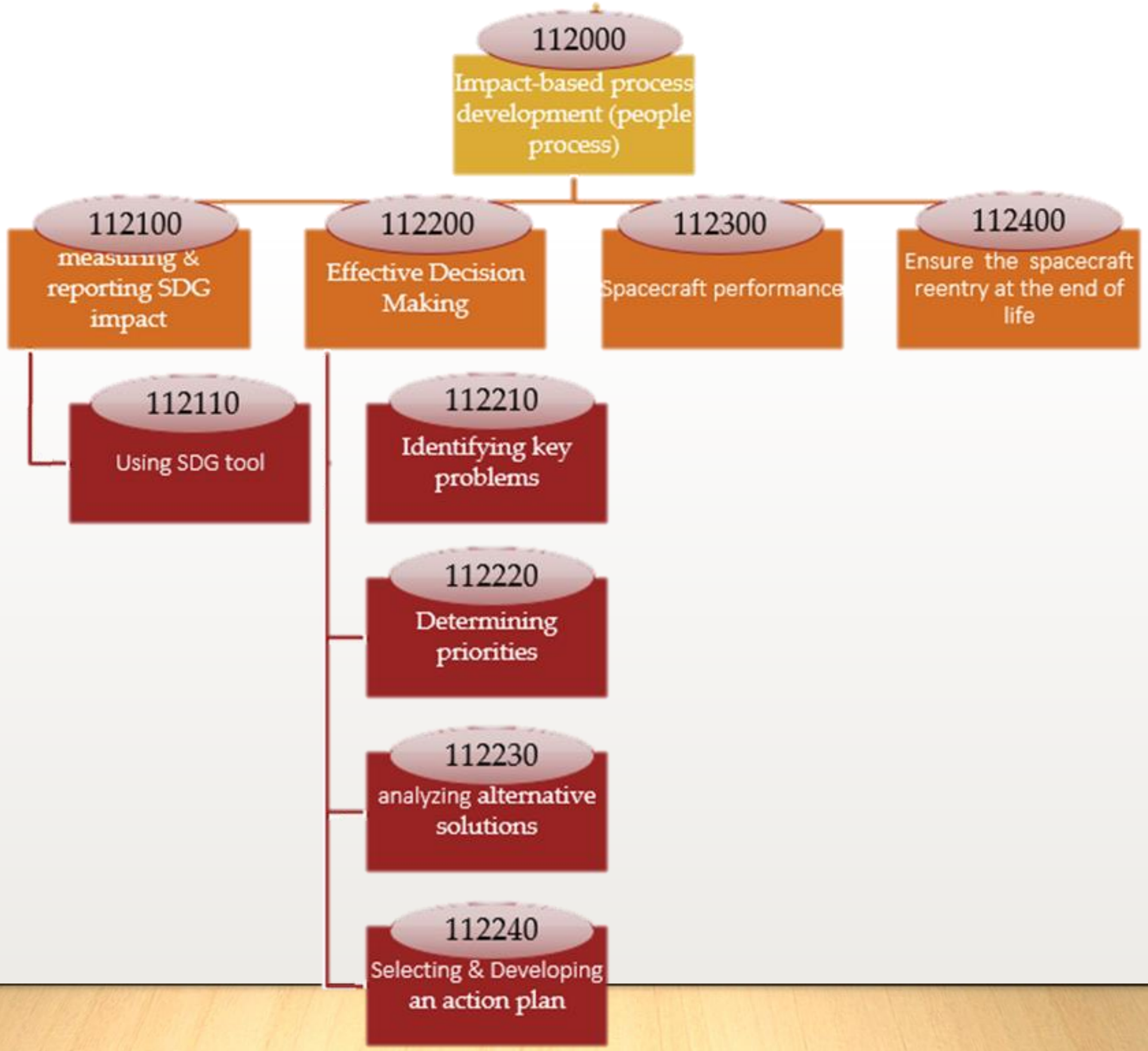
110


111000
Community connection (people process)
111100
The interested communities
111200
Have a good facilitator to guide the conversation
111300
Training our team
111110
Research and contact communities
111120
Educational communities



Phase (A)

111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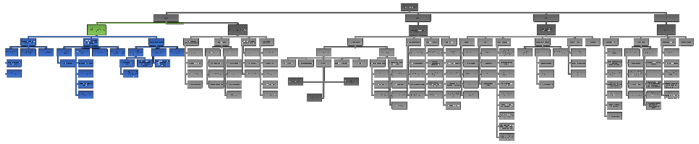
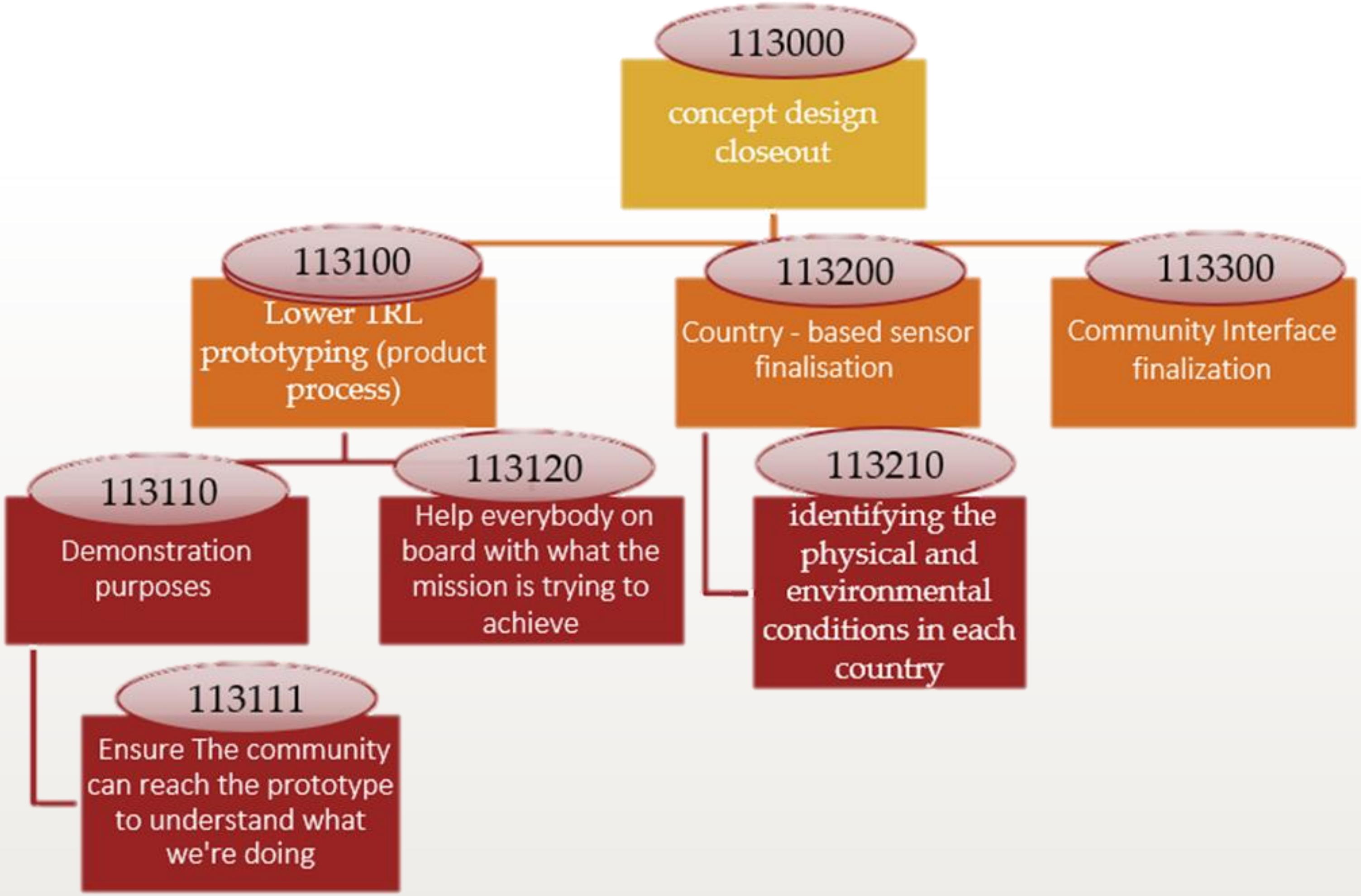
Impact-based process development (people process)
112100
measuring & reporting SDG impact
112200
Effective Decision Making
112300
Spacecraft performance
112400
Ensure the spacecraft reentry at the end of life
112110
Using SDG tool
112210
Identifying key problems
112220
Determining priorities
112230
analyzing alternative solutions
112240
Selecting & Developing an action plan

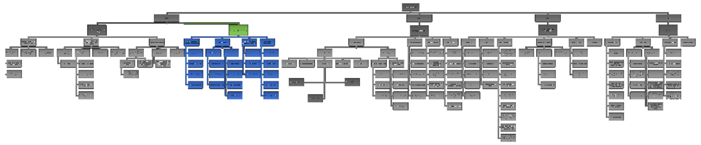
Phase (A)

112



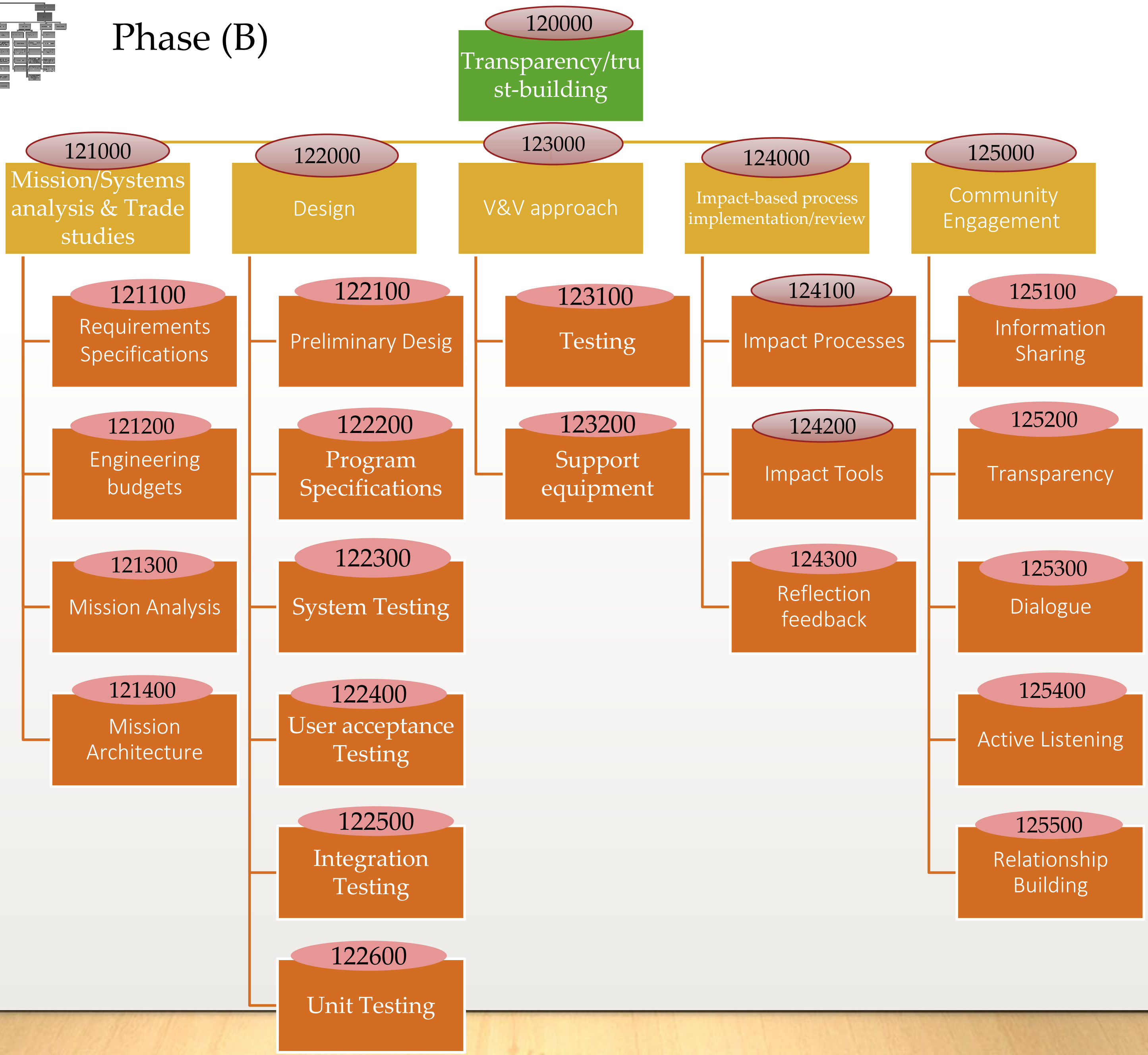


113000
concept design closeout
113100
Lower TRL prototyping (product process)
113200
Country - based sensor finalisation
113300
Community Interface finalization
113110
Demonstration purposes
113120
Help everybody on board with what the mission is trying to achieve
113210
identifying the physical and environmental conditions in each country
113111
Ensure The community can reach the prototype to understand what we're doing



Phase (B)

113


120000
Transparency/trust-building
121000
Mission/Systems analysis & Trade studies
122000
Design
123000
V&V approach
124000
Impact-based process implementation/review
125000
Community Engagement
121100
Requirements Specifications
121200
Engineering budgets
121300
Mission Analysis
121400
Mission Architecture
122100
Preliminary Desig
122200
Program Specifications
122300
System Testing
122400
User acceptance Testing
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Integration Testing
122600
Unit Testing
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Testing
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Support equipment
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Impact Processes
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Impact Tools
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Dialogue
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Active Listening
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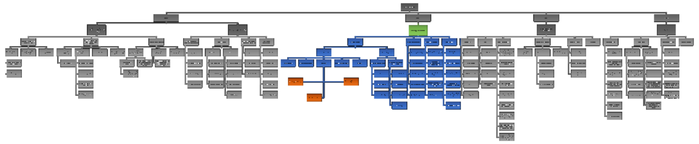
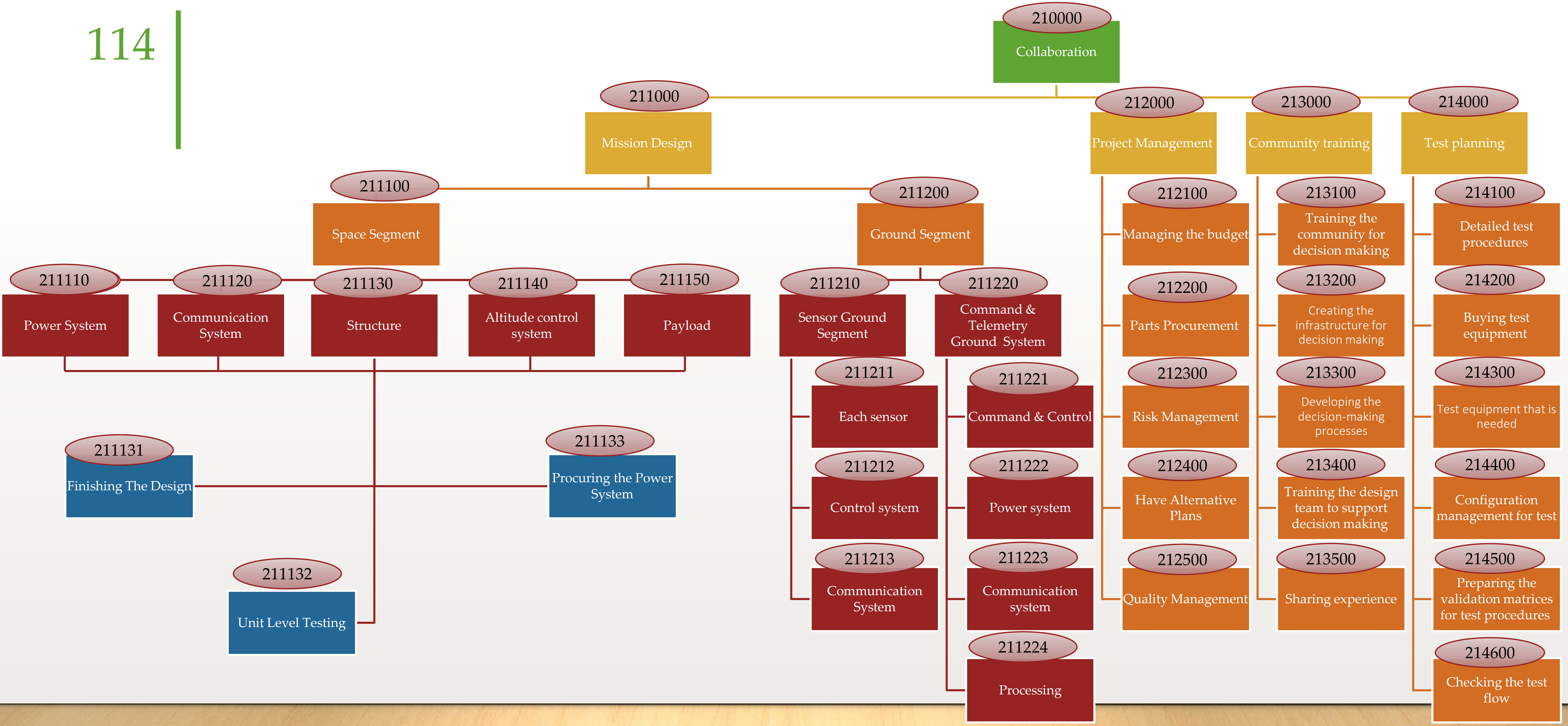
Relationship Building



Phase (C)

114



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Collaboration
211000
Mission Design
212000
Project Management
213000
Community training
214000
Test planning
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Space Segment
211200
Ground Segment
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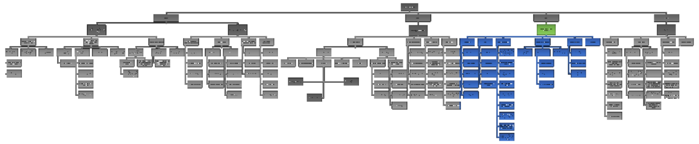
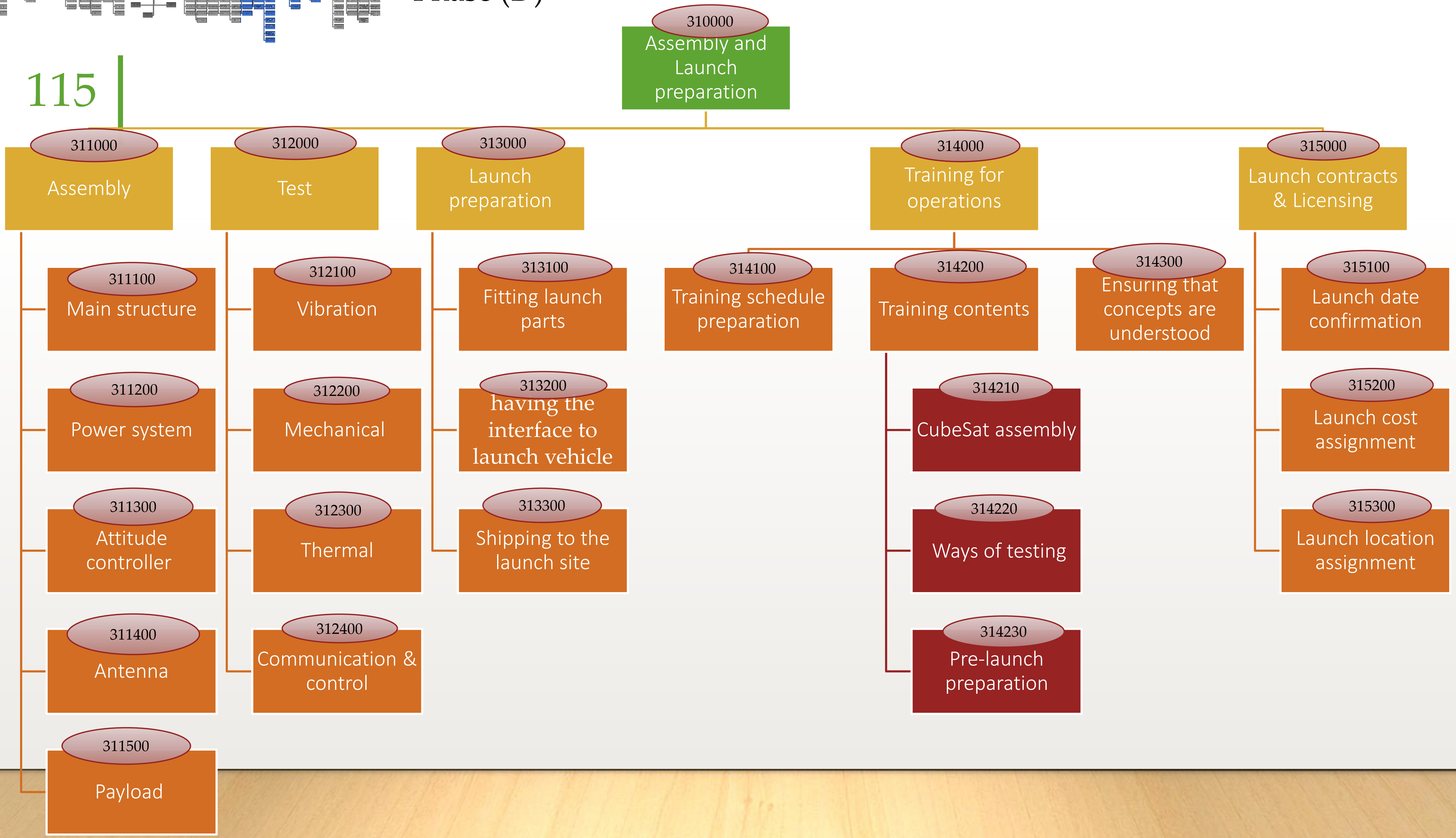
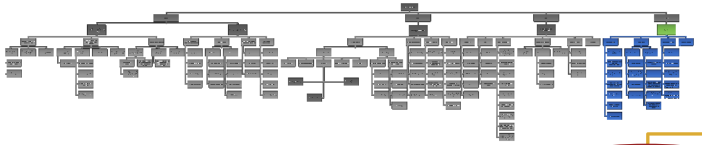
Power System
211120
Communication System
211130
Structure
211140
Altitude control system
211150
Payload
211131
Finishing The Design
211132
Unit Level Testing
211133
Procuring the Power System
211210
Sensor Ground Segment
211211
Each sensor
211212
Control system
211213
Communication System
211220
Command & Telemetry Ground System
211221
Command & Control
211222
Power system
211223
Communication system
211224
Processing
212100
Managing the budget
212200
Parts Procurement
212300
Risk Management
212400
Have Alternative Plans
212500
Quality Management
213100
Training the community for decision making
213200
Creating the infrastructure for decision making
213300
Developing the decision-making processes
213400
Training the design team to support decision making
213500
Sharing experience
214100
Detailed test procedures
214200
Buying test equipment
214300
Test equipment that is needed
214400
Configuration management for test
214500
Preparing the validation matrices for test procedures
214600
Checking the test flow



Phase (D)


310000
Assembly and Launch preparation
311000
Assembly
311100
Main structure
311200
Power system
311300
Attitude controller
311400
Antenna
311500
Payload
312000
Test
312100
Vibration
312200
Mechanical
312300
Thermal
312400
Communication & control
313000
Launch preparation
313100
Fitting launch parts
313200
having the interface to launch vehicle
313300
Shipping to the launch site
314000
Training for operations
314100
Training schedule preparation
314200
Training contents
314210
CubeSat assembly
314220
Ways of testing
314230
Pre-launch preparation
314300
Ensuring that concepts are understood
315000
Launch contracts & Licensing
315100
Launch date confirmation
315200
Launch cost assignment
315300
Launch location assignment



Phase (E)

- **Operation**
  - 411000 Commissioning
    - 411100 Ensure Requirements are met.
    - 411200 Ensure installation aligns with the project documents.
    - 411300 Ensure the goals of the design are met.
    - 411400 Ensure efficient operation within expected energy modeling.
    - 411500 Defect-Free Upon Delivery.
    - 411600 Effective & secure maintenance.
    - 411700 Fully documented.
  - 412000 Operations
    - 412100 Ground operations.
      - 412110 Mission Control.
      - 412120 Development and maintenance of flight and ground segment software.
      - 412130 Data Validation.
      - 412140 Data Processing.
    - 412200 Flight operations.
      - 412210 Trajectory Monitoring.
      - 412220 Instantaneous decision-making.
      - 412230 Plan and carry out daily plans in coordination with several control centers and worksites.
      - 412240 Using flight systems to resolve in-orbit anomalies in a timely manner.
      - 412250 Validate immediate plans based on the constraints of the design.
  - 413000 Community Handoff
    - 413100 Providing Assistance
    - 413200 Providing Equipment
    - 413300 Providing information about the conditions and availability of water resources.
    - 413400 Providing reliable means of communication.
  - 414000 Lessons Learned

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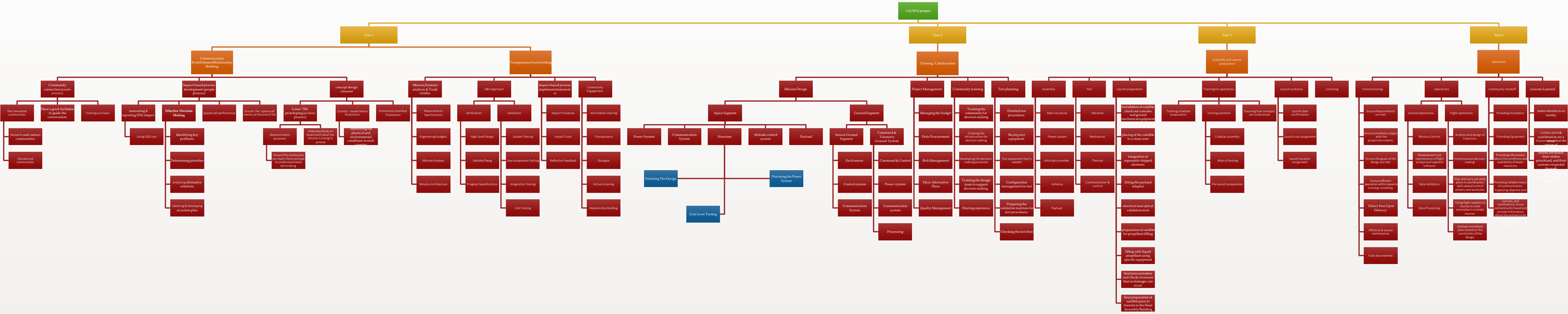


CEUWM project
Year 1
Year 2
Year 3
Year 4
Communication Establishment/Relationship Building
Transparency/trust-building
Training/Collaboration
Assembly and Launch preparation
Operation
Mission Design
Space Segment
Ground Segment
Power System
Communication System
Structure
Payload
Finishing The Design
Procuring the Power System
Unit Level Testing
Project Management
Community training
Test planning
Lessons Learned

Preliminary budgeting

- Space segment

Sub Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
	40,867	51713	62056

- Ground segment

  - In Canada

Sub Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
	10,169	12,274	14728.8
Sub Total (x10)	101,690	122740	147288

  - In Uganda

Sub Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
	10,511	12,685	15222
Sub Total (x10)	105,110	126,850	152,220

Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
	4206,800	249,590	299,508

Preliminary budgeting (cont.)

- Other components for ground sensors

Sub Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
	1,563.5	1,932.8	2,319.3
Sub Total (x10)	15,635	19,328	23,193

- Payload SMS/Ground Communication

Sub Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
	249	370	444
Sub Total (x5)	1245	1850	2220

Preliminary budgeting (cont.)

- Command and Data Handling

	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
Sub Total	275	412	495
Sub Total (x5)	1375	2060	2472

- Community Training Cost
  - In Canada

	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
Sub Total	8688	10426	12511

  - In Uganda

	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
Sub Total	8172	9806	11768

	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
Total	16,860	20,232	24279

Preliminary budgeting (cont.)

- Communication and Feedback (website)

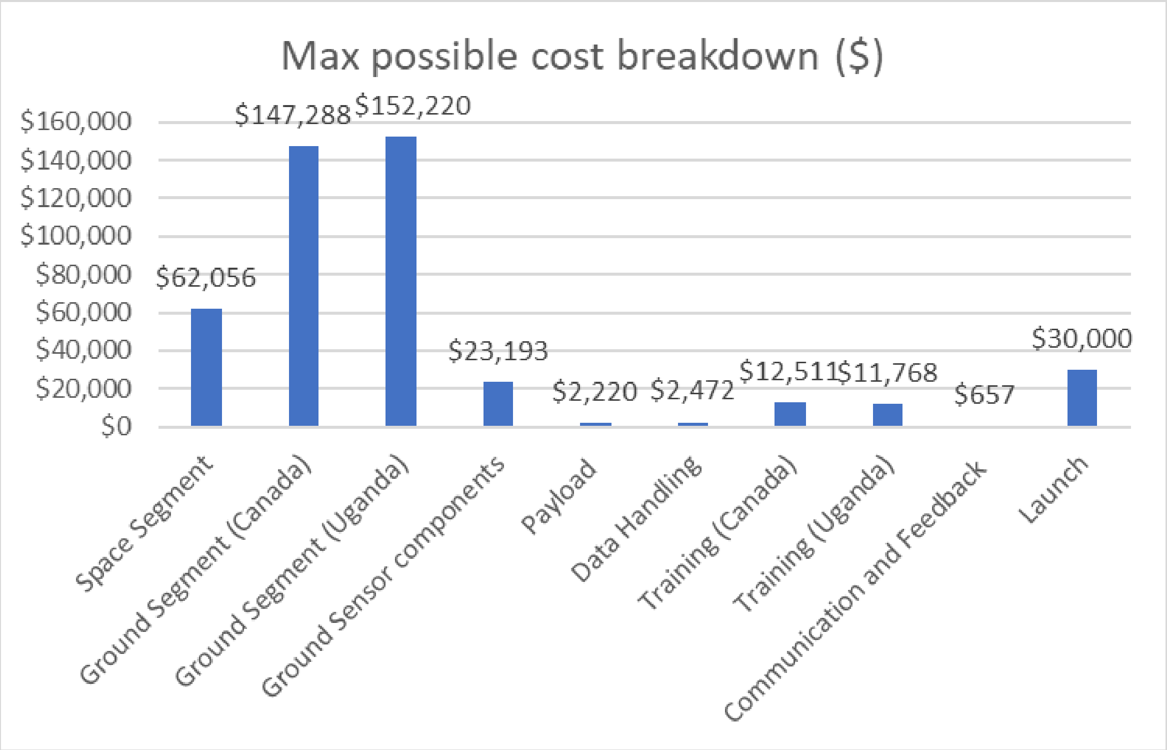
Sub Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%)
	456	547	657

- Launch Cost

Sub Total	Expected Cost Range ($)	Maximum Expected Cost ($)	Maximum Possible Cost (Margin 20%) ($)
	12500	25000	30000

Preliminary budgeting (cont.)

Max possible cost breakdown			
Element	2022	2021	% Increase
Space Segment	$62,056	$62,698	-1.02%
Ground Segment (Canada)	$147,288	$123,986	18.79%
Ground Segment (Uganda)	$152,220	-	-
Ground Sensor components	$23,193	$23,032	0.70%
Payload	$2,220	$2,047	8.45%
Data Handling	$2,472	$3,105	-20.39%
Training (Canada)	$12,511	$11,520	8.60%
Training (Uganda)	$11,768	-	-
Communication and Feedback	$657	$691	-4.92%
Launch	$30,000	$132,600	-77.38%
Total	$444,385	$359,679	23.55%



Preliminary budgeting (cont.)

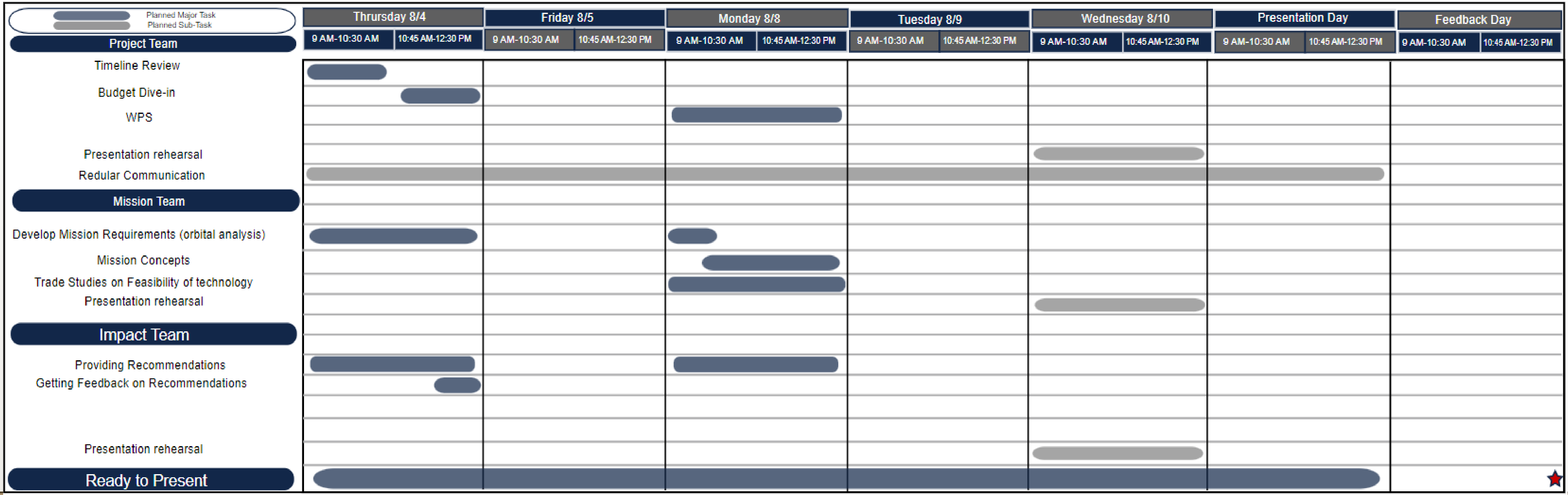
- Notes
  - Space segment labor cost and testing cost are considered free
  - Ground segment building & testing cost, labor cost as well as land cost are sponsored by the government and charities.
  - Online training is conducted as possible to minimize costs.
  - Food transportation and housing prices are lower in Uganda.

Risk Assessment

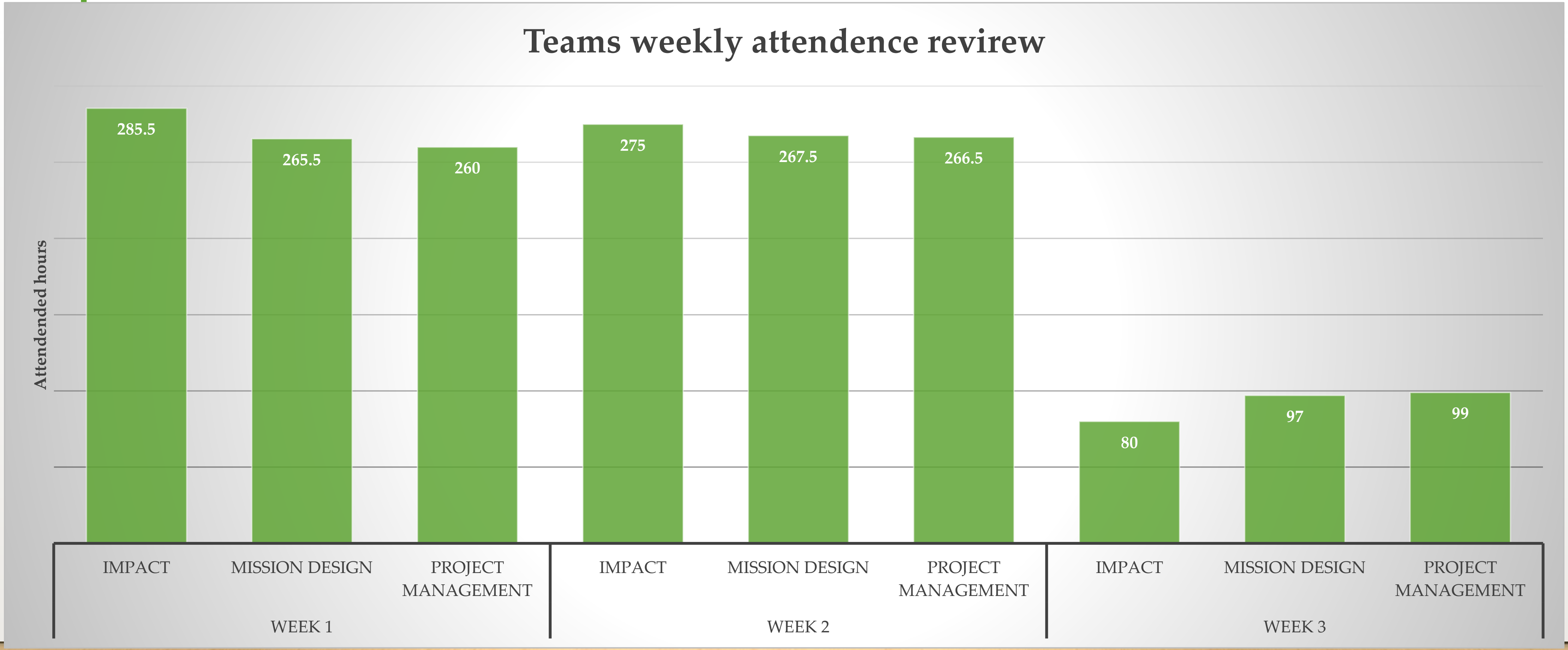
NO	Risk	Cause	Consequences	Likelihood	Severity	Risk rank	How it can be mitigated?
1	Phases obstruction	Closure due to any pandemic	Mission delay	3	4		Doing the work online when it is possible
2	Higher inflation rate	Fluctuating costs	Inaccurate cost estimation	5	3		▪ Get all required components as early as possible. ▪ Set higher contingencies to things that can't be obtained early
3	sponsors withdraw from funding the mission	Costs can't be sustained	Mission cancellation	1	5		Provide a well persuasive report that shows mission feasibility
4	Severe deviation from timeline	Mission delay	Loss of trust	4	4		▪ Preparing a well-studied timeline ▪ Avoid getting too busy
5	Communities are no longer need to the mission	Mission cancellation	Loss of money and reputation	1	5		Don't go through the mission without ensuring that communities need the mission

Risk Assessment

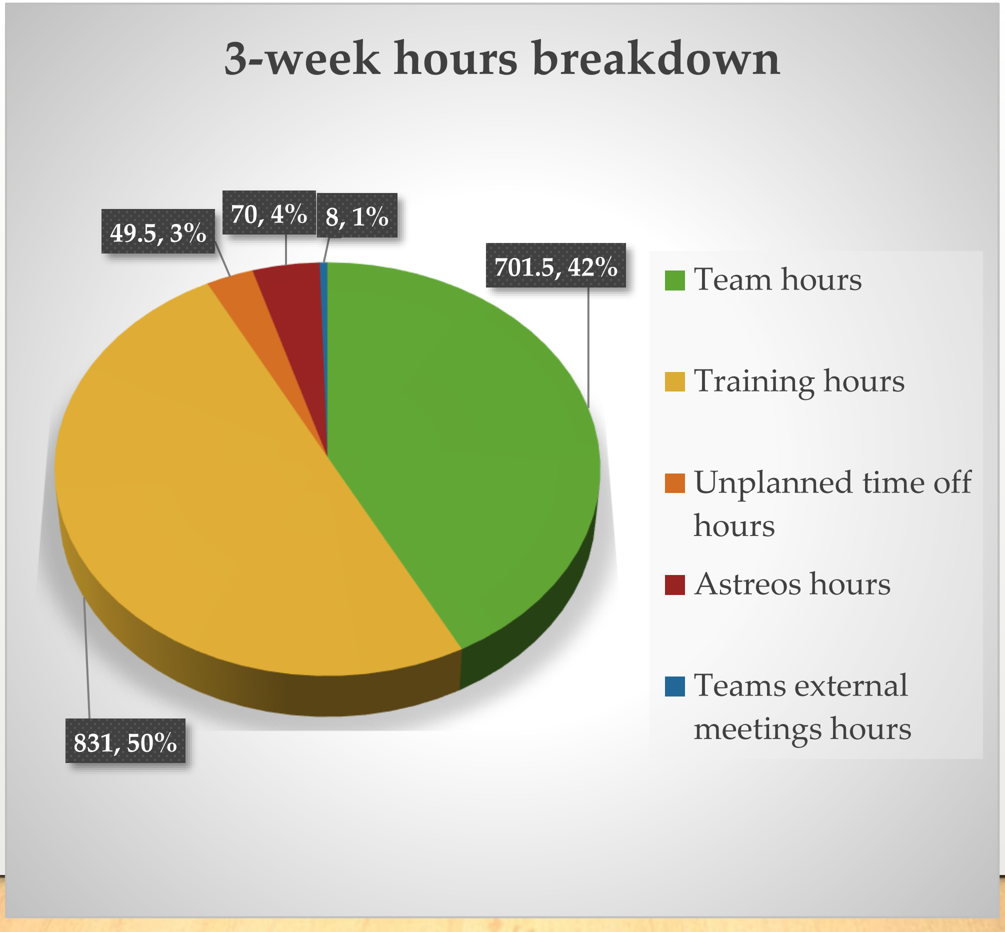
3-week timeline



3-week hours attendance

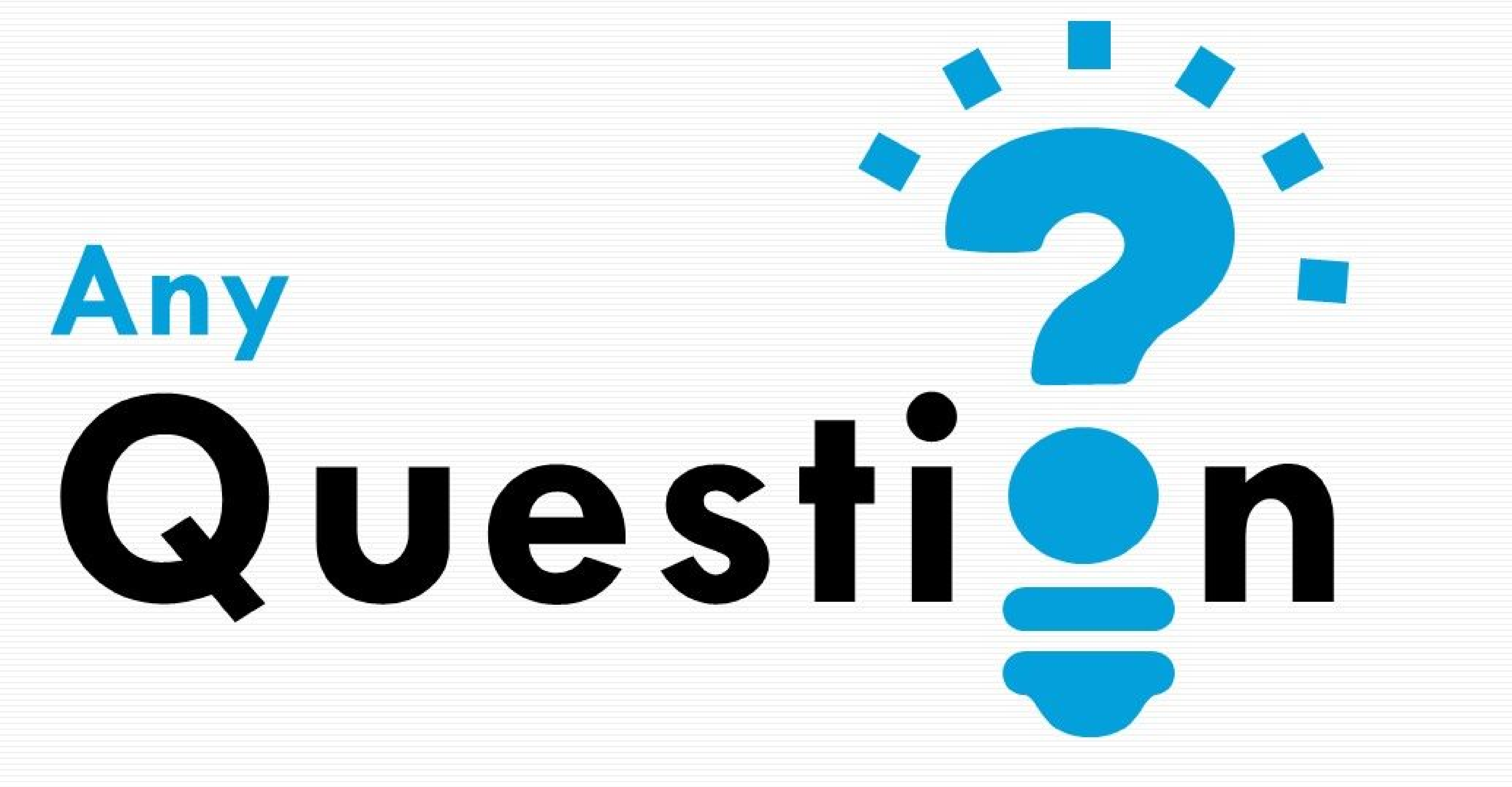


3-week hours attendance (cont.)



Recommendations

- All teams' tasks should be studied precisely
- A detailed schedule for work packages should be provided


Any
Question