Public Talk: Advanced GIS Technologies and its use…

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Content

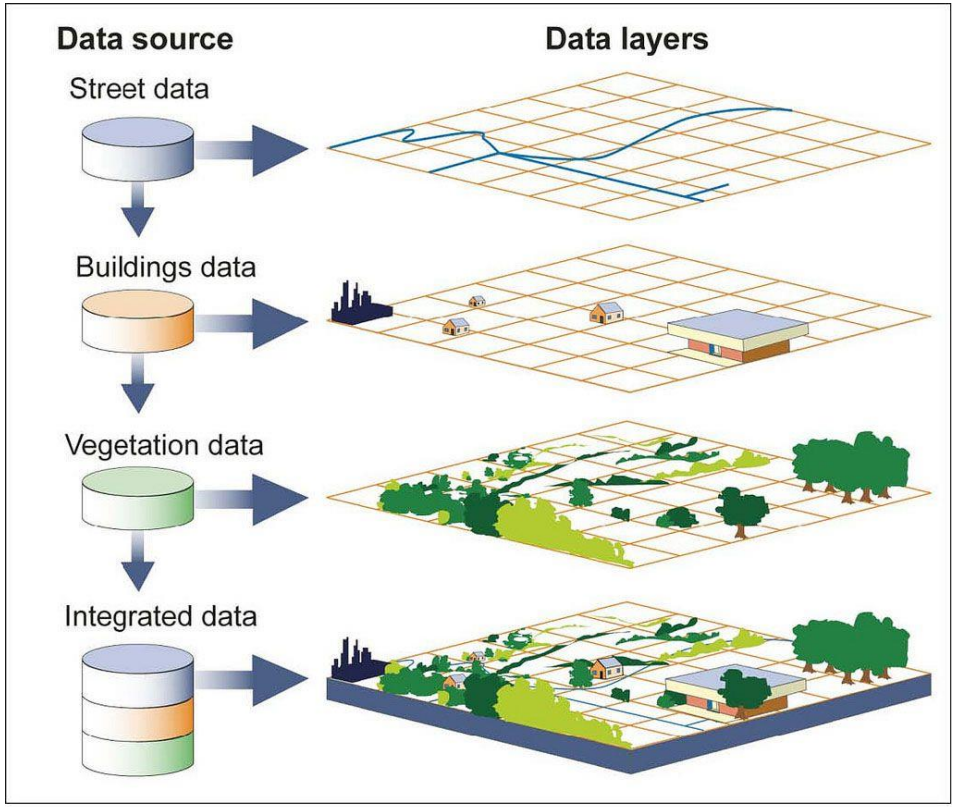
- Introduction
- Functions of a GIS system
- Applications of GIS
- GIS Technologies
- Case Study: Use of GIS & NLP for Historical data
- PhD Research Concept
- Conclusion

Geographic Information Science (GIScience) – science and technology that uses information science infrastructures to solve problems of geography and related disciplines of science and engineering.

A **GIS** system **-** A spatial system that creates, manages, analyses and map datasets relating to positions on Earth. (ESRI)

- Connects data to a map.
- Integrates location data to descriptive information.
- Provides a foundation for mapping and analysis used in science. and other industries.

- Data entry
- Data Management
- Data Display
- Information retrieval
- Analysis and representation



Source: GAO.

❖ Identify & understand patterns

❖ Relationships

❖ Geographic context

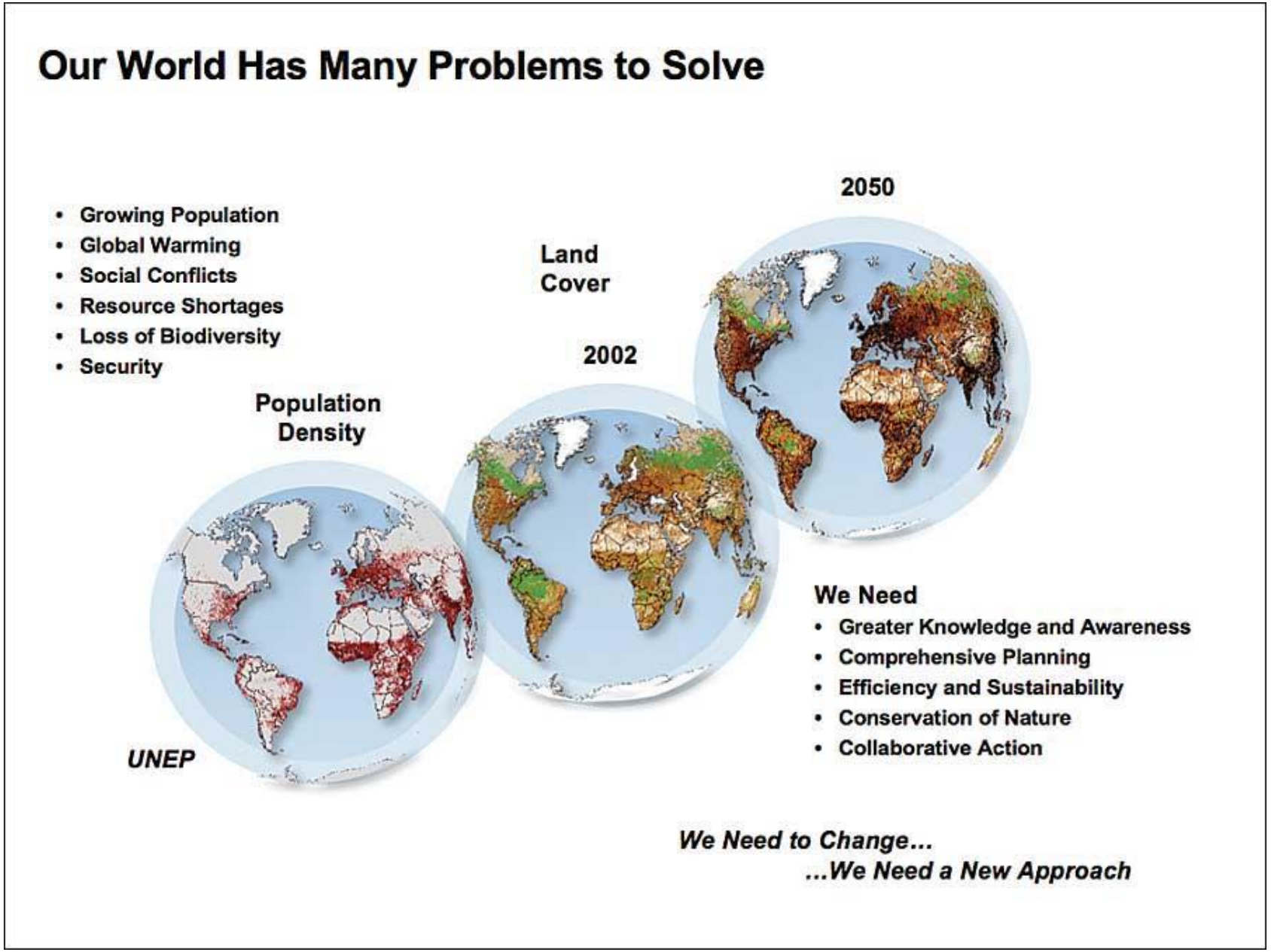


Image Source: Esri

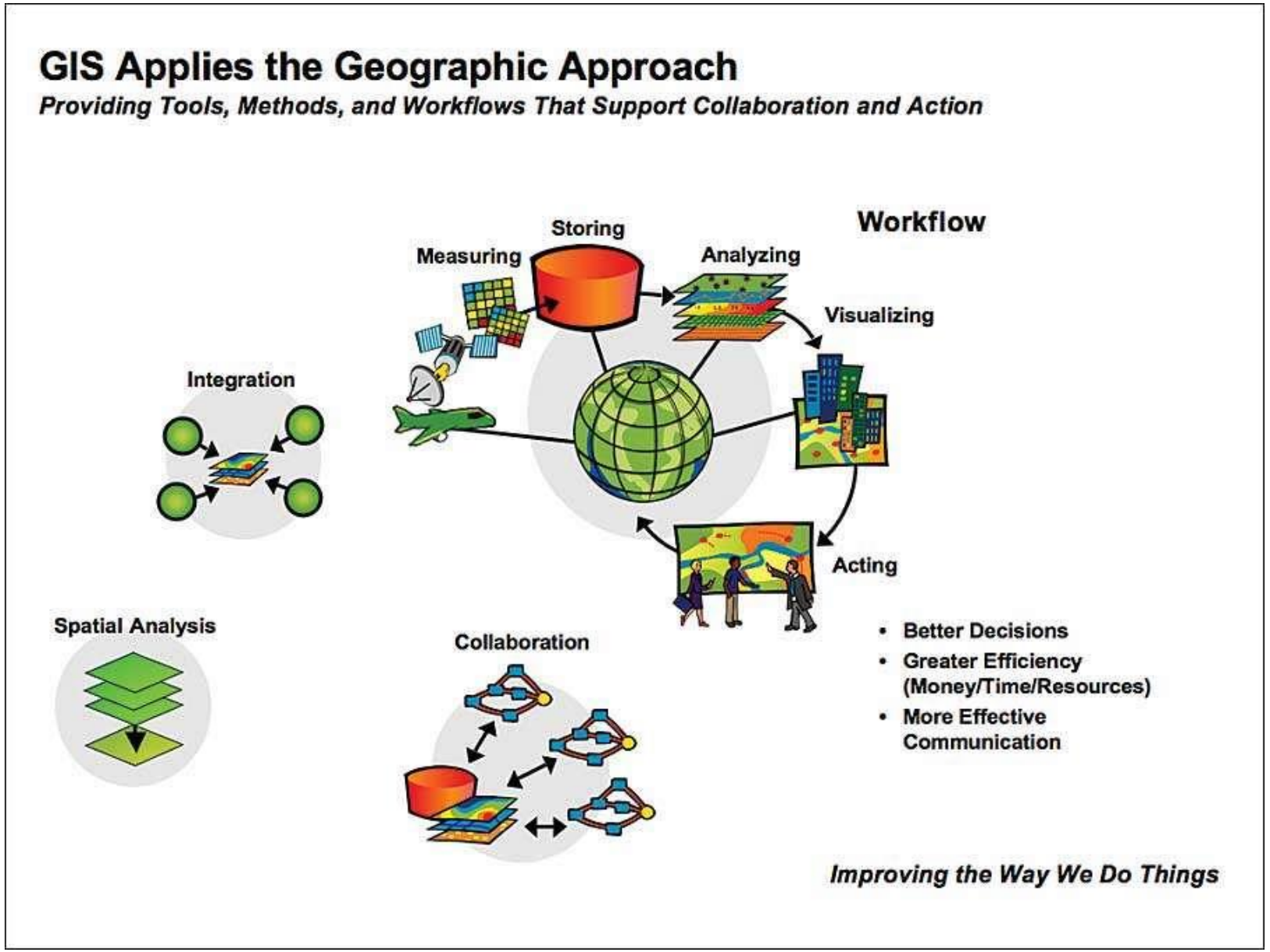
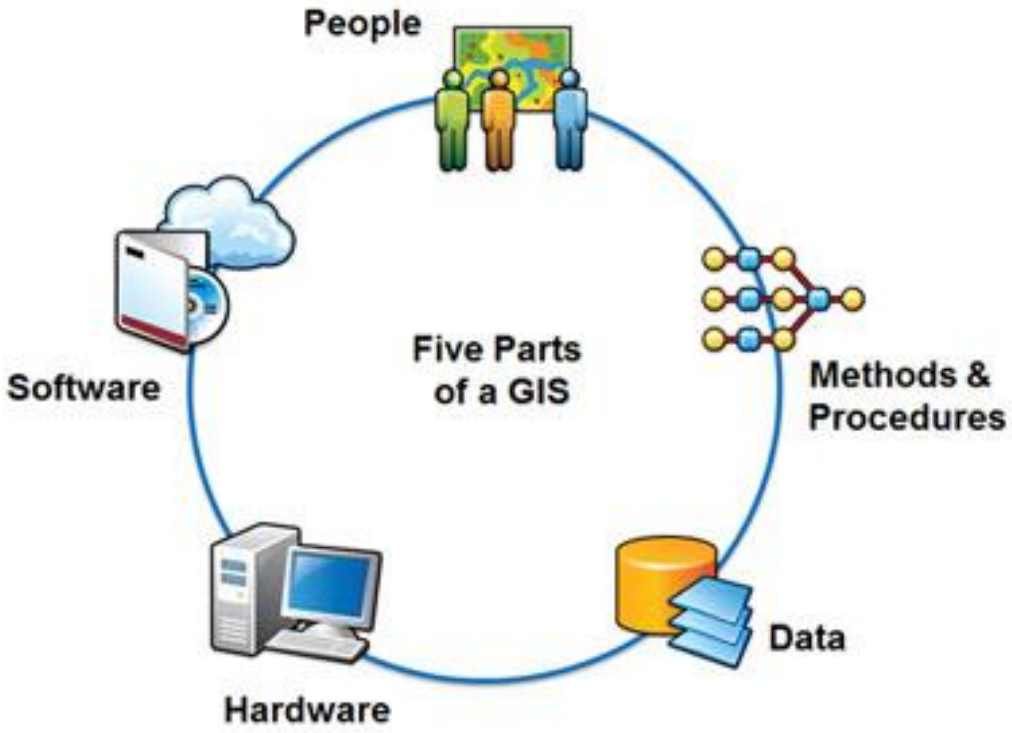


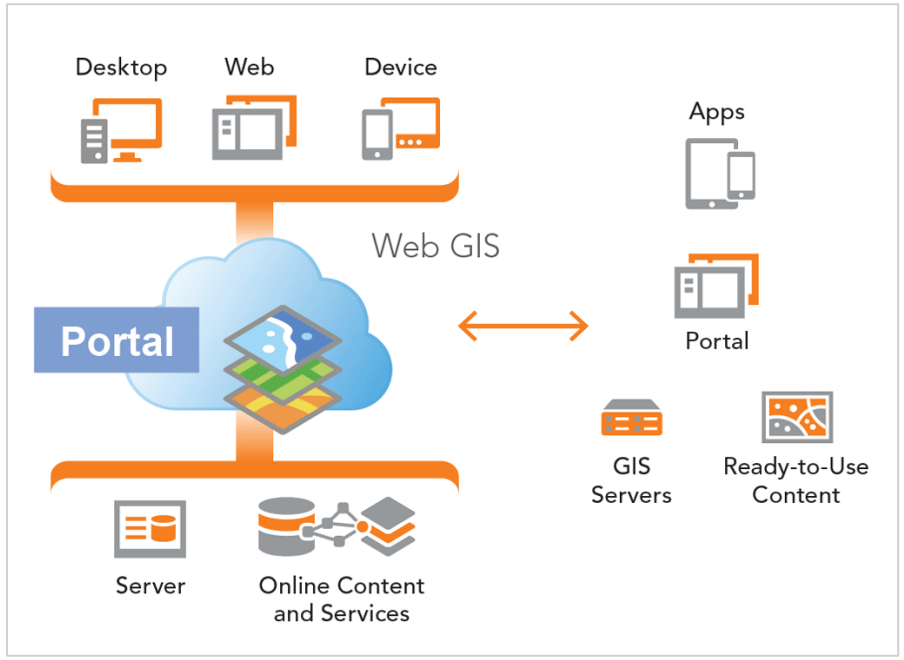
Image Source: Esri

GIS in an organization:

ArcGIS

QGIS



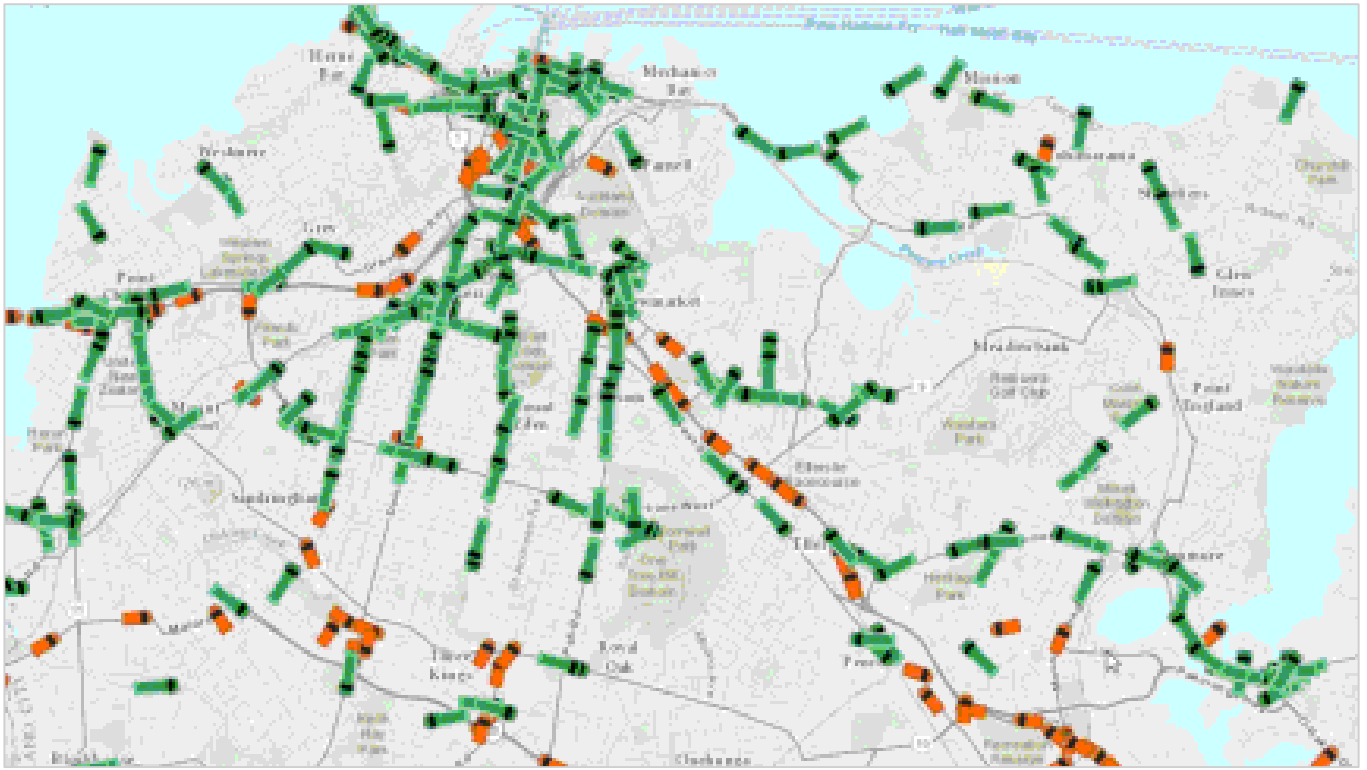


- Identifying problems
- Monitoring change
- Forecasting
- Managing and responding to events
- Identifying & setting priorities
- Feasibility studies
- Understanding trends

Recent GIS Technologies & Services:

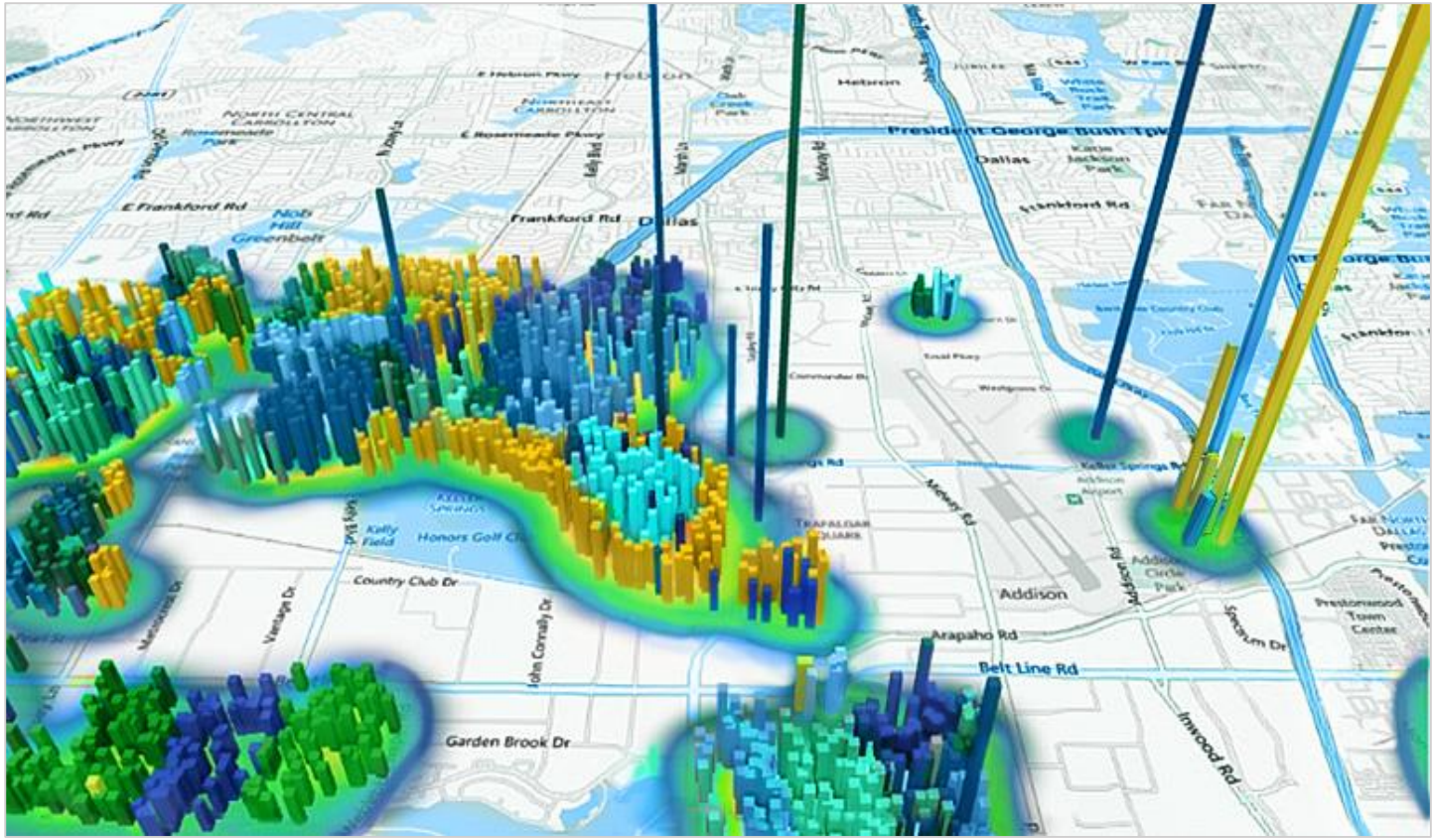
- Cloud based IT infrastructure and Externally hosted GIS services
- Web-based mapping platforms and location-based services
- Participatory GIS and crowd sourcing of GIS data and mobile apps
- Advances in Open Source GIS Software
- The need of 24/7 operations and services to users

Real time GIS – Situation Analysis



- Traffic count & fleet management
- Weather monitoring i.e.. Hurricanes & Cyclones

Consumer - facing Information – Real Estate



- Evaluating neighbourhoods
- Evaluating properties

Geo Artificial Intelligence - GeoAI

- Integrating GI and AI
- Developing intelligent programs to mimic the process of human perception, spatial reasoning and discovery of geographic features.
- In order to advance our knowledge
- And solve problems in human-environmental systems & their interactions
  - ❖ Infrastructure Maintenance
  - ❖ Location Based Information for Food delivery business
  - ❖ Tailored content based on a person's location

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GeoAI – Geo Artificial Intelligence

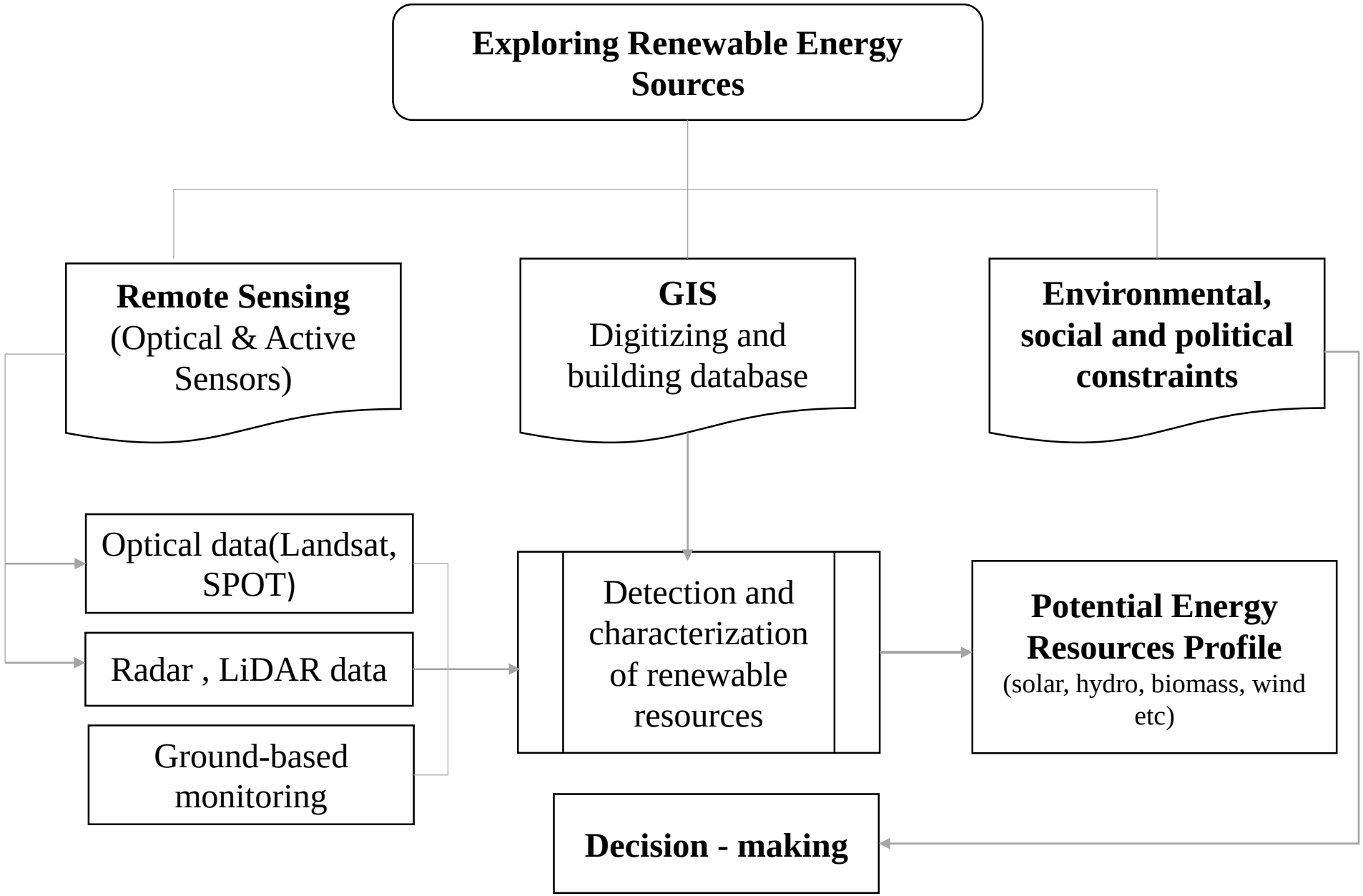
Energy Resource mapping

A powerful toolkit:

- Identifying potential energy sources (spatially and temporally)
- Deep analysis of wind, solar and biomass potential etc.
- Model energy transmission network
- Integrate influencing factors such as population, distance to cities, distance to existing grid network etc.

Energy Resource mapping

- Mapping Wind turbines
- Assessing solar potential on rooftops



GIS in Education

A powerful toolkit:

- Administration,
- Policy making and
- Educational instruction

✓ Explore relationships among objects

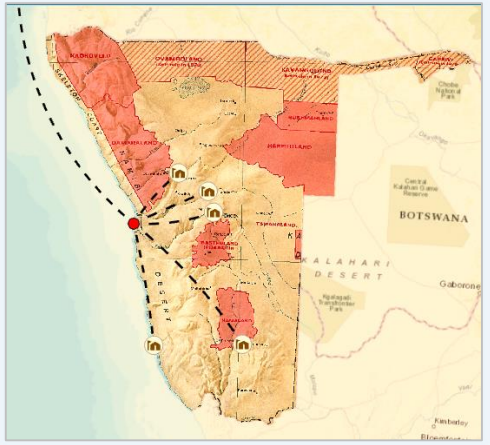
✓ Better understanding of contents in varied disciplines

Use of GI and Natural language Processing for Historical records

Case study: German- Herero war of resistance 1904

Master Thesis

Case Study Background



- 1880s German Settlers arrived in SWA.
- Spread across the country
- Early 1900's the resistance struggle began.
- Hereros revolted in 1904.
- Germany responded by sending approx. 15000 troops under General Von Trotha.
- Battle of Hamakari, 11 August 1904 – **Hereros defeated.**

Source: Resistance struggle 1904 by Klaus Dierks

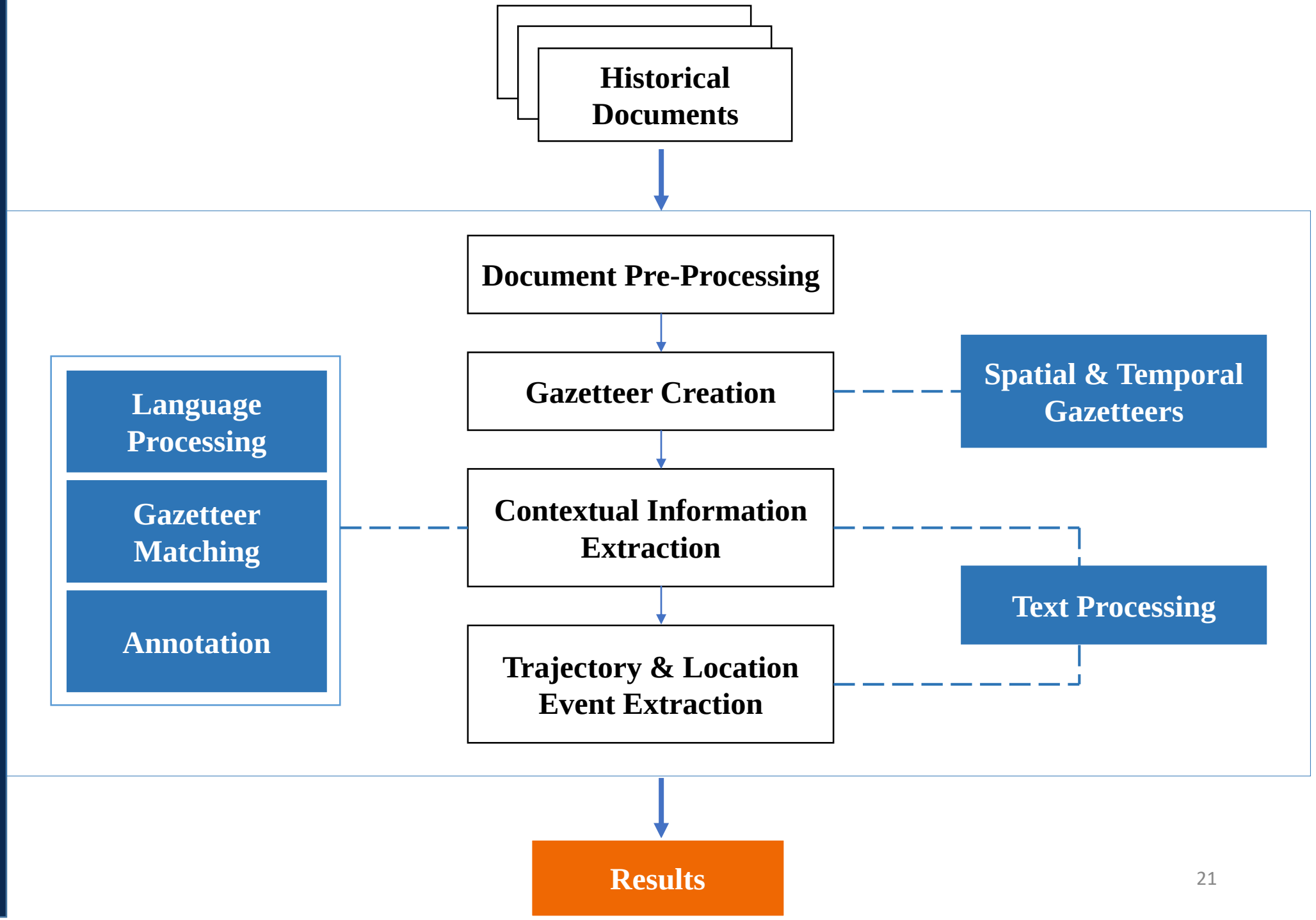
Source data:

Book sources:

1. Let us die fighting (Drechsler, 1966)
2. The revolt of the Hereros (Bridgman, 1981)
3. South West Africa under German rule (Bley, 1971)

Websites and online articles:

1. Chronology of the Namibian history (Dierks, 2000)
2. Herero Uprising 11 January 1904 (Namibia-10n1, 2013)



Gazetteer Creation:

What do we want?

- Temporal expressions
- Spatial expressions
- Attributive information (Person's names)

Spatial Gazetteer

- **ANNIE** gazetteer
- List of place names – 3859 place names

Gazetteer Creation:

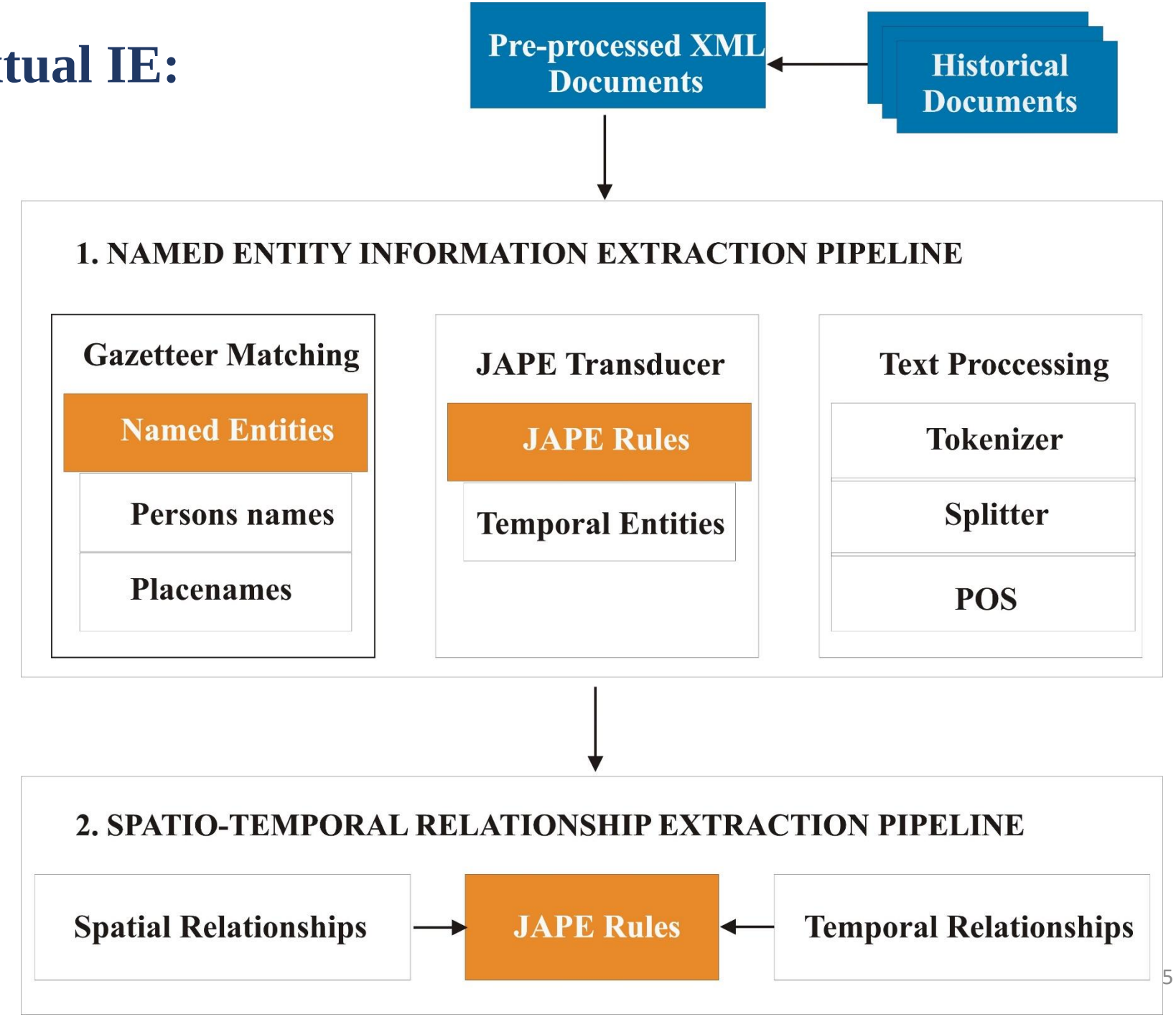
Temporal Gazetteer

- **JAPE** grammar rule
- Date Expressions – 7 Pattern rules

No.	Entity	Pattern
1	Date	June 1904
2	Date	June 13
3.	Date	June 13, 1904
4.	Date	13 June
5.	Date	13 June 1904
6.	Date	11.06
7.	Date	11.06.1904

```
Phase: datetimefinder
Input: Token Lookup SpaceToken
Options: control = appelt

////////////////////////////////////Macros
//Initialization of regular expressions
Macro: DAY_ONE
({Token.kind == number,Token.category==CD, Token.length == "1"})

Macro: DAY_TWO
({Token.kind == number,Token.category==CD, Token.length == "2"})

Macro: YEAR
({Token.kind == number,Token.category==CD, Token.length == "4"})

Macro: MONTH
({Lookup.minorType=="month"})


////////////////////////////////////////////Rule 6
//For date format 12.08 for 12 August
Rule: numberdate
Priority: 50
(
    (DAY_ONE|DAY_TWO)
    ({Token.string == ","}|{Token.string == "."} |{Token.string == "-"})
    (DAY_ONE|DAY_TWO)
    ({Token.string == ","}|{Token.string == "."} |{Token.string == "-"})?
)
:numberdate
-->
    :numberdate.NumberDate= {rule = "numberdate"}

```

Contextual IE:

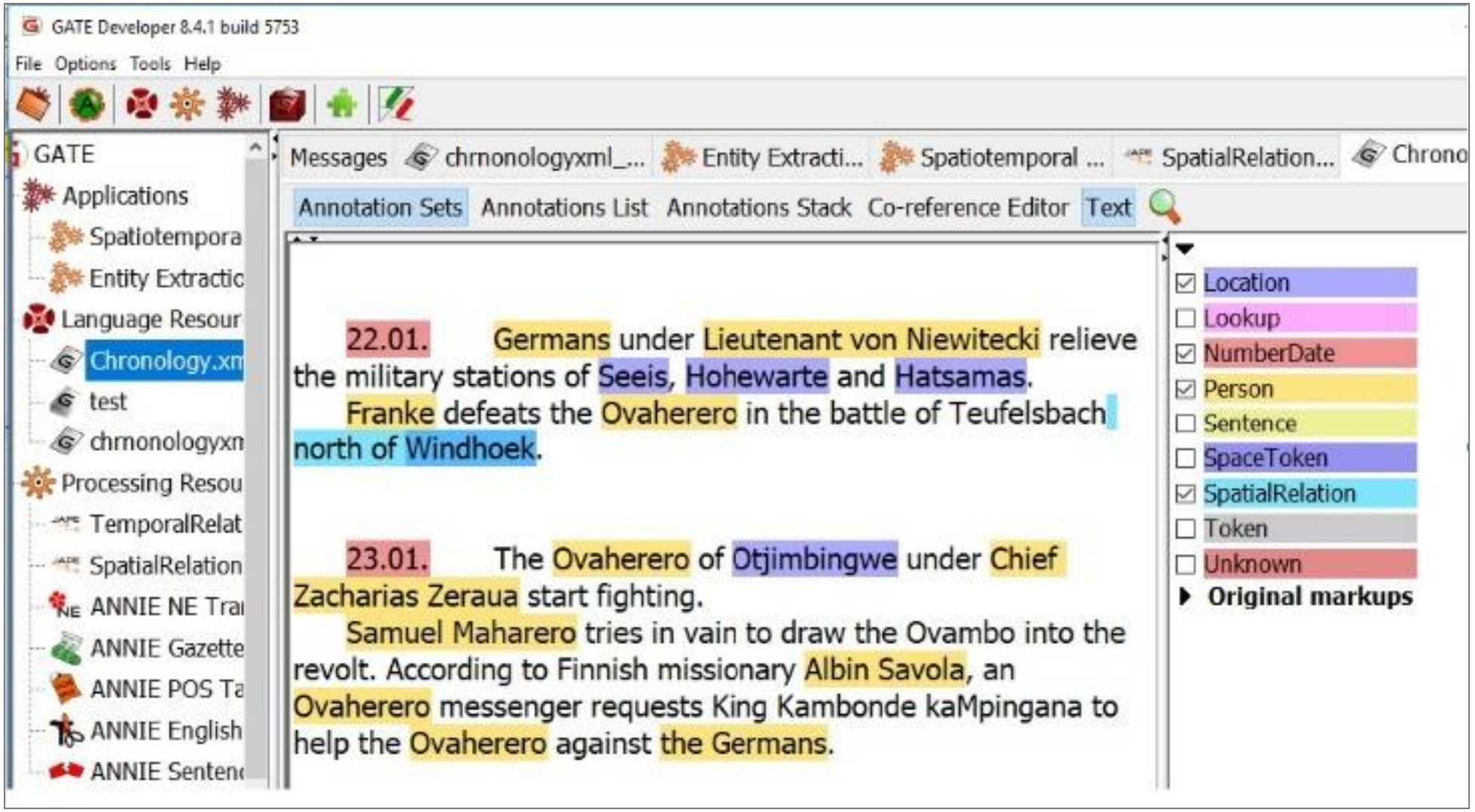


Entity Extraction Pipeline

28./29.03.	Zeraua leaves the area of Oruware and moves via Teufelsbach to the east.
30.03.	Zeraua joins the Otjimbingwe and Omaruru Ovaherero at Samuel's station at Ongandjira in the upper Swakop valley.
01.04.	Von Glasenapp's unit proceeds in the direction of Otjikuoko without meeting the Tjetjo community.
03.04.	Tietio meets the Germans in a battle at a site between Okaharui and Otjikuara with heavy losses on both sides.

- ✓ **Date**
- ✓ **Person**
- ✓ **location**
- ✓ **Spatio-temporal relationships**

GATE annotation framework:



GATE Annotation Results:

```
<?xml version="1.0" encoding="UTF-8"?>
<document xmlns:gate="http://www.gate.ac.uk" gate:gateId="0" gate:annotMaxId="28690" title="The Resistance Struggle culminates in genocide: 1904-1906">
<paragraph gate:gateId="1" date="11.01" id="100">
<sentence gate:gateId="2" id="101">
<NumberDate gate:gateId="28273" rule="numberdate">11.01.</NumberDate>
<Person gate:gateId="28443" firstName="Samuel" rule="PersonFull" ruleFinal="PersonFinal" gender="male" surname="Maharero" kind="fullName">Samuel Maharero
orders all
<Person gate:gateId="28444" rule="GazPerson" ruleFinal="PersonFinal" surname="Ovaherero" kind="fullName">Ovaherero</Person>
chiefs to take up arms against
<Person gate:gateId="28445" firstName="the" rule="GazPerson" ruleFinal="PersonFinal" surname="Germans" kind="fullName">the Germans</Person>
.
</sentence>
<sentence gate:gateId="3" id="102">He orders them to &amp;quot;refrain from touching missionaries, English, Basters, Berg-Damaras, Namas and Boers&amp;quot;
<sentence gate:gateId="4" id="103">There are doubts concerning the date of this order.</sentence>
<sentence gate:gateId="5" id="104">
It is possible that
<Person gate:gateId="28446" rule="GazPerson" ruleFinal="PersonFinal" surname="Maharero" kind="fullName">Maharero</Person>
wrote this letter after the outbreak of the war (around
<NumberDate gate:gateId="28274" rule="numberdate">20.01.</NumberDate>
), after the first shots were fired in
<Location gate:gateId="28447" rule="InLoc1" ruleFinal="LocFinal" locType="town" kind="locName">Okahandja</Location>
, where it is not clear at all, who actually fired these first shots (Missionary Diehl reports that only
<Person gate:gateId="28448" firstName="the" rule="GazPerson" ruleFinal="PersonFinal" surname="Germans" kind="fullName">the Germans</Person>
fired on his house, not the
<Person gate:gateId="28449" rule="GazPerson" ruleFinal="PersonFinal" surname="Ovaherero" kind="fullName">Ovaherero</Person>
).
</sentence>
<sentence gate:gateId="6" id="105">
<Person gate:gateId="28450" firstName="Samuel" rule="PersonFull" ruleFinal="PersonFinal" gender="male" surname="Maharero" kind="fullName">Samuel Maharero
tries to involve the Basters, under
<Person gate:gateId="28451" firstName="Hermanus" rule="GazPerson" ruleFinal="PersonFinal" surname="van Wyk" kind="fullName">Hermanus van Wyk</Person>
and
<Person gate:gateId="28452" firstName="Hendrik" rule="GazPerson" ruleFinal="PersonFinal" surname="Witbooi" kind="fullName">Hendrik Witbooi</Person>
, in the struggle. The two letters
<Person gate:gateId="28453" rule="GazPersonFirst" firstName="Samuel" ruleFinal="PersonFinal" gender="male" kind="firstName">Samuel</Person>
```

Trajectory & location events extraction

- Combine to ***Location event(Persons' name, Location, Date)***
- Chronological order – as per text document
- Write to PostgreSQL Database
- Produce individual trajectories

Input: XML Document D, Paragraph P, Sentence E
Results: combine[T, S, N]
where T= Temporal term, S = Spatial term, N = personNames

Begin:

Parse D,
For each Paragraph P in D do:
Get paragraph date as Pd
For each Sentence E in P do:
If only S and N **then**
assign Pd as T
combine (T, S, N)
If only one T, one S and N **then**
combine(T, S, N)
If multiple T and one S **then**
assign S to each T , combine(T1, S, N), combine(T2, S, N)....
If multiple S and one T **then**
assign T to each S, combine(T, S1, N), combine(T, S2, N).....
If multiple S and multiple T and one N **then**:
if S == T then
combine(T1, S1, N), combine(T2, S2, N)....
If multiple T, multiple S and multiple N **then**
if T == S == N **then**
combine(T1, S1, N1), combine(T2, S2, N2)....

Else
Jump to next sentence
Return combine(T, S, N)

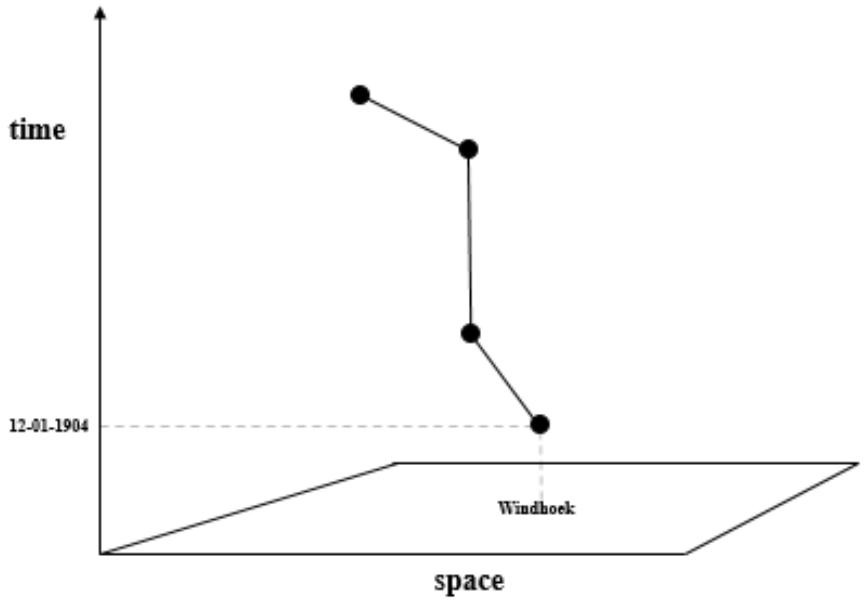
End

	person text	location text	date text	temporalrelation text	spatialrelation text	sentenceid integer
97	Tjetjo	between Otjiku...	03.04.1904		between Otjikuara	3201
98	the Germans	between Otjiku...	03.04.1904		between Otjikuara	3201
99	Samuel Maharero	Okatumba	10.04.1904			3401
100	Samuel Maharero	Oviumbo	10.04.1904			3401
101	the Germans,Leutwein,Ovaherero	Oviumbo	13.04.1904			3501
102	the Germans,Leutwein,Ovaherero	Otjosazu	13.04.1904			3501
103	Von Glasenappâ	Otjihangwe	24.04.1904			3502
104	Von Glasenappâ	Otjihaenena	24.04.1904			3502
105	Ovaherero	Waterberg	19.04.1904			3601
106	the Germans	Engarawau	19.04.1904			3602
107	Ovaherero	Okangundi	28.04.1904			3701
108	Arthur Koppel	Warmquelle	20.05.1904		near Zesfontein	3901
109	Kutako	Tsumeb	06.08.1904			4803
110	Herero	Waterberg	10.08.1904			5002
111	Von Estorff	Okomiparum	10.08.1904			5003

✓ **263 location events**

Historical Spatio-temporal data

1. Location visit events – Location events in time
2. Individual trajectories – Moving points in time
3. Battle events – Location events in time



Theory of a moving point in time

Modelling historical events in ArcGIS

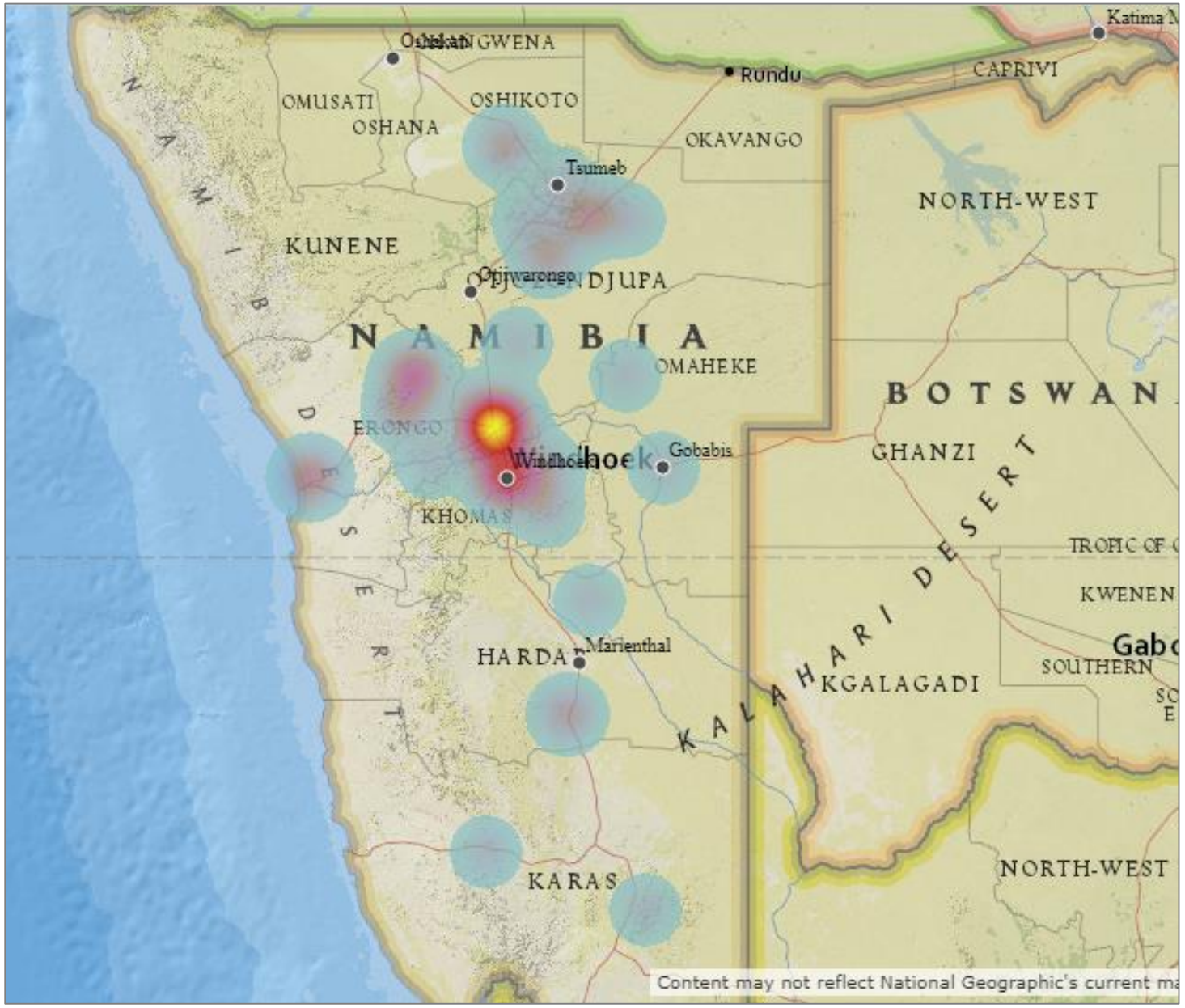
We are interested in:

- Space and existence in time ⟶ **Where & When?**
- Change in position & time
- Spatial relationships in time

tjetjo

Shape *	date	person	location	latitude	longitude	loc_vistid	group	end_date
Point	06/01/1904	Tjetjo	Gobabis	-22.45	18.9717	1	Herero	11/03/1904
Point	11/03/1904	Tjetjo	Onjati Mountains	-22.19	17.4378	82	Herero	12/03/1904
Point	12/03/1904	Tjetjo	Onjatu	-20.94	16.44	89	Herero	13/03/1904
Point	13/03/1904	Tjetjo	Owikokorero	-21.9832	16.9131	90	Herero	01/04/1904
Point	01/04/1904	Tjetjo	Otjikuoko	-21.69	17.31	99	Herero	03/04/1904
Point	03/04/1904	Tjetjo	Between Okaharui and Otjiku	-21.65269	17.519	100	Herero	15/05/1904
Point	15/05/1904	Tjetjo	Tsumeb	-19.24444	17.7122	117	Herero	01/09/1904
Point	01/09/1904	Tjetjo	Epata	-21.00775	18.8763	189	Herero	01/09/1904
Point	01/09/1904	Tjetjo	Otjinene	-21.13833	18.785	191	Herero	01/09/1904
Point	01/09/1904	Tjetjo	Omuramba - Omatako	-21.15907	16.7186	192	Herero	16/09/1904
Point	16/09/1904	Tjetjo	Oruaromunjo	-20.864	20.784	203	Herero	16/09/1904

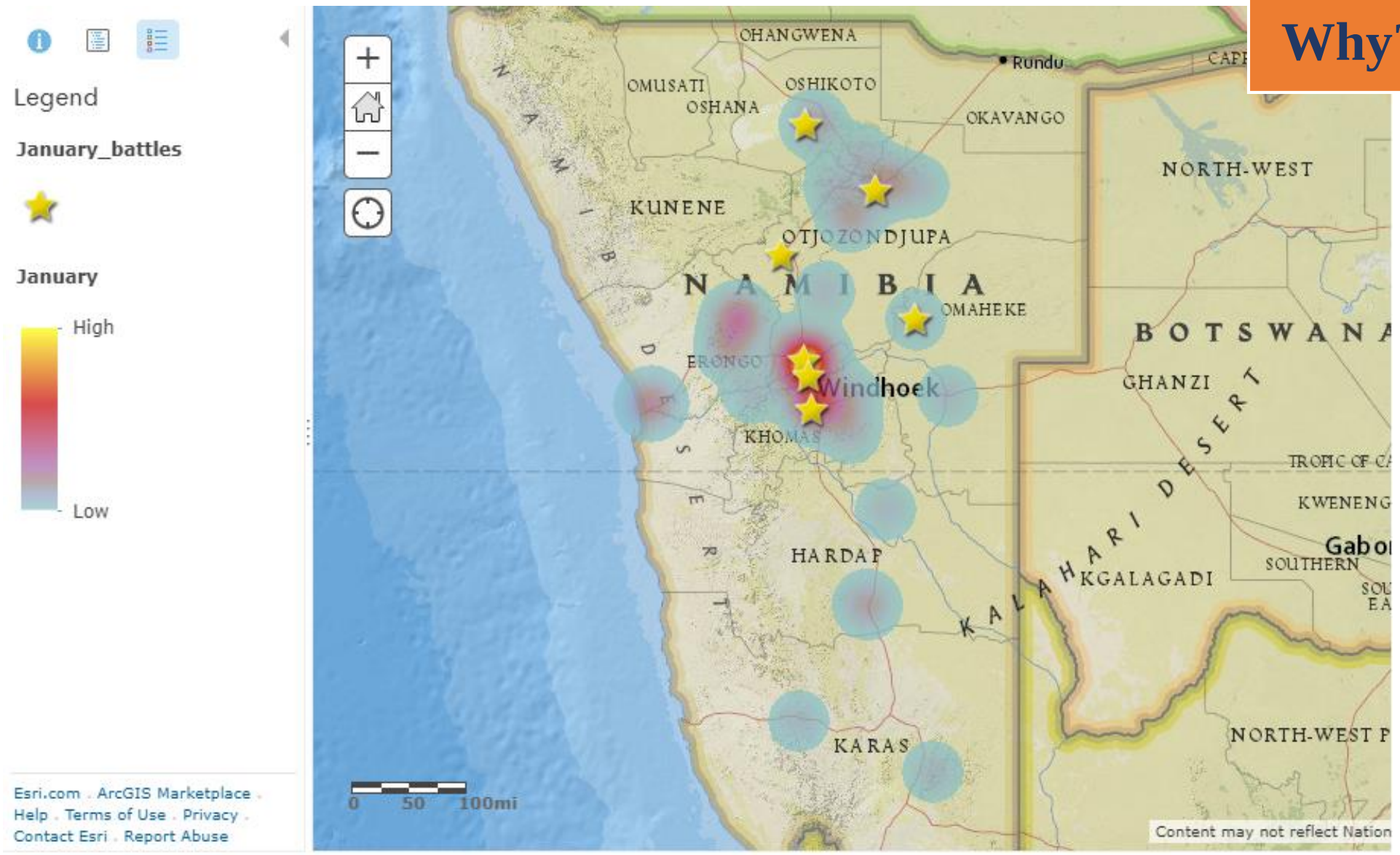
Spatio-temporal Cluster Analysis – January location events



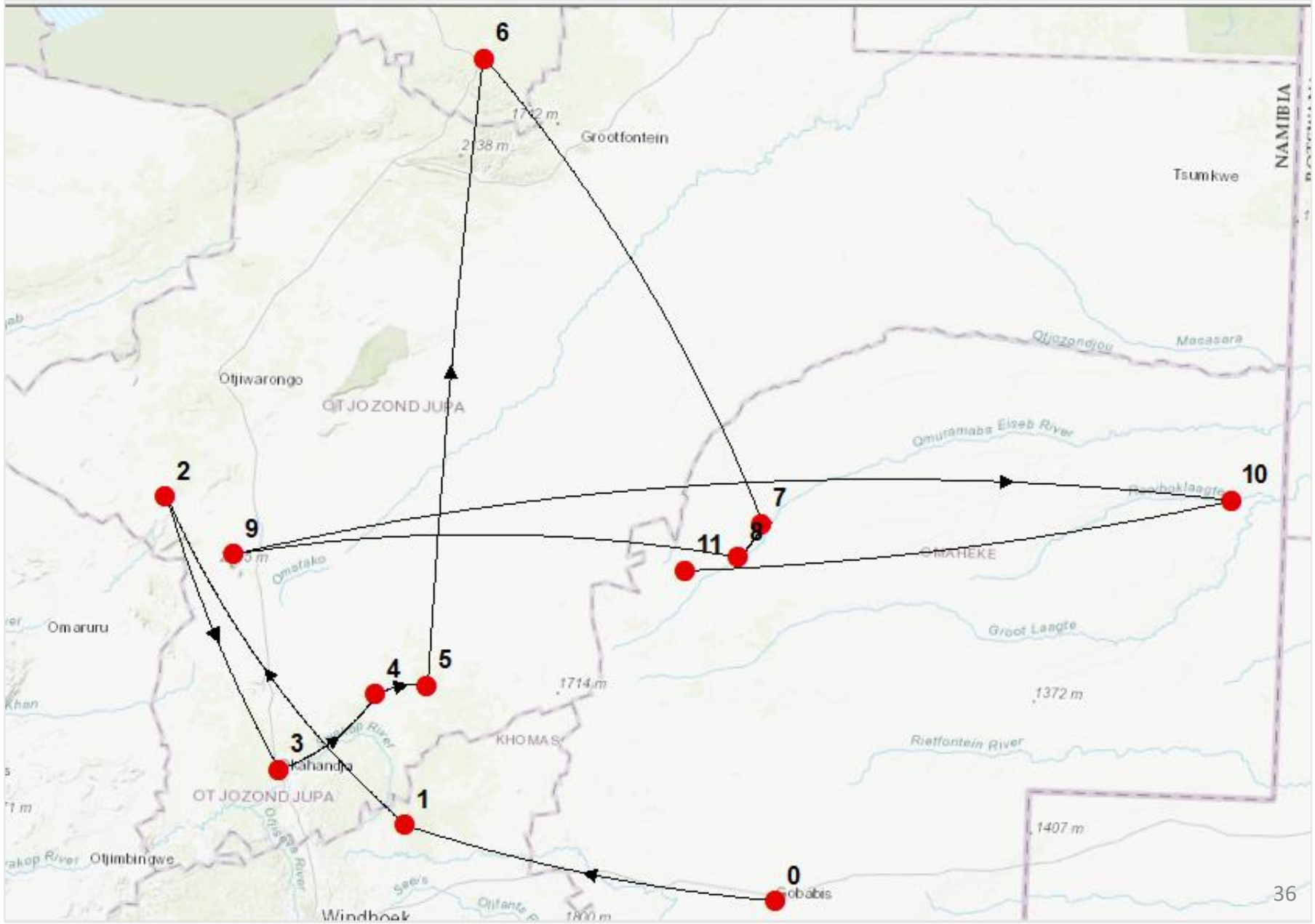
- **Answers *"Where?"***

Spatio-temporal Cluster Analysis – January location events

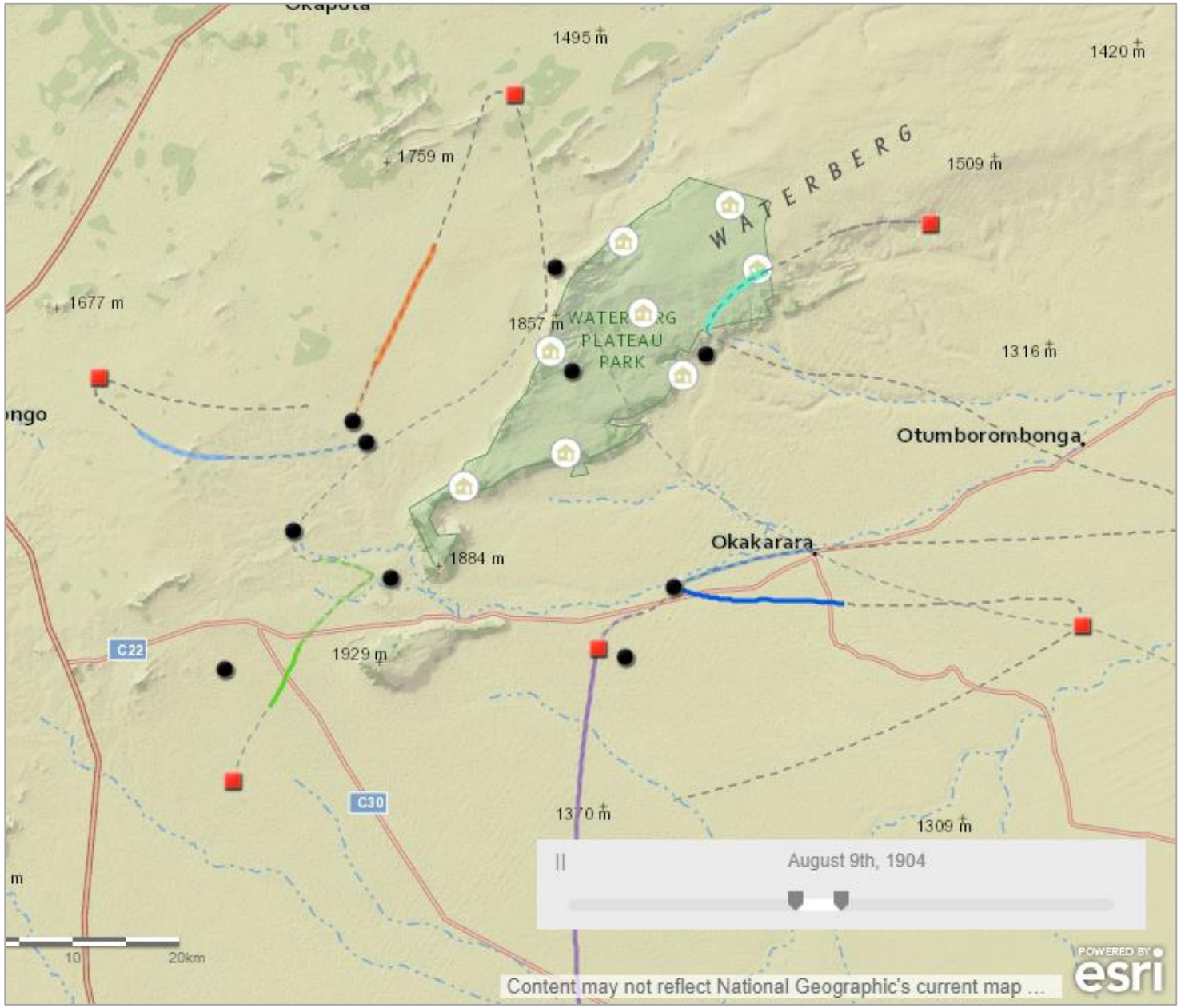
Why?



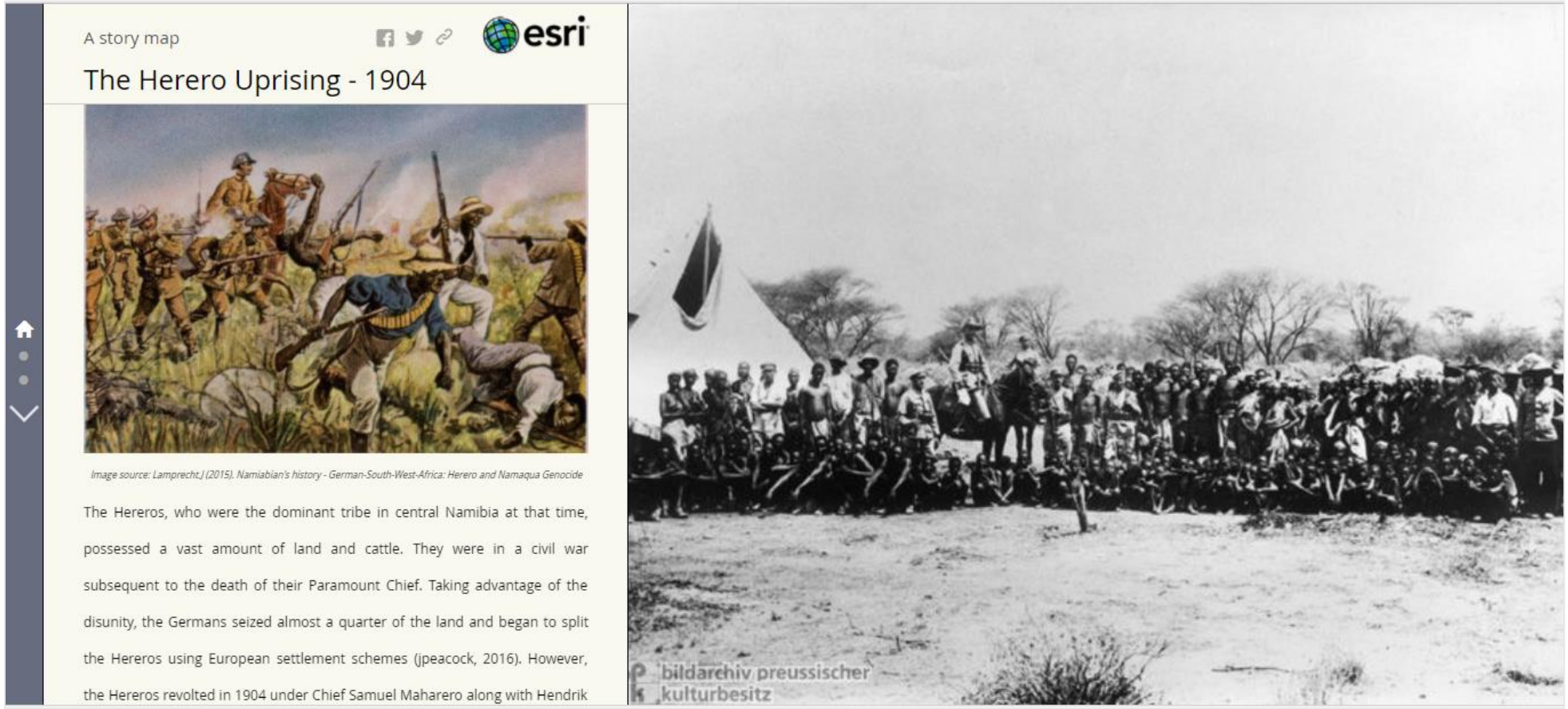
Trajectory representations



Time –Aware Map

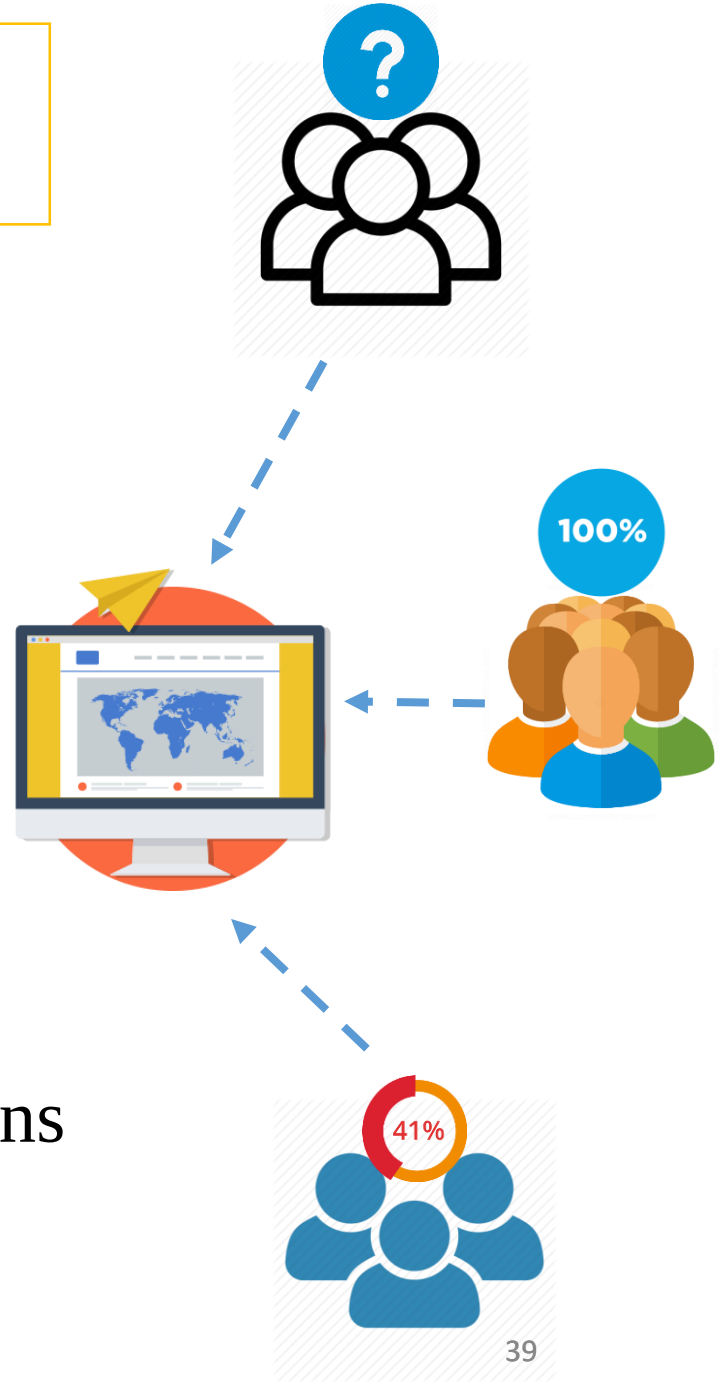


Story Map Journal



A pattern-based usability framework for GI Web applications

- Usability - **quality** of using an application.
- Strong usability - **effective, efficient usage**
- Weak usability – ✖
- To **support** planning and decision making processes.



✓ **Improve** usability of GI Web Applications

Aspects of usability in GI web applications:

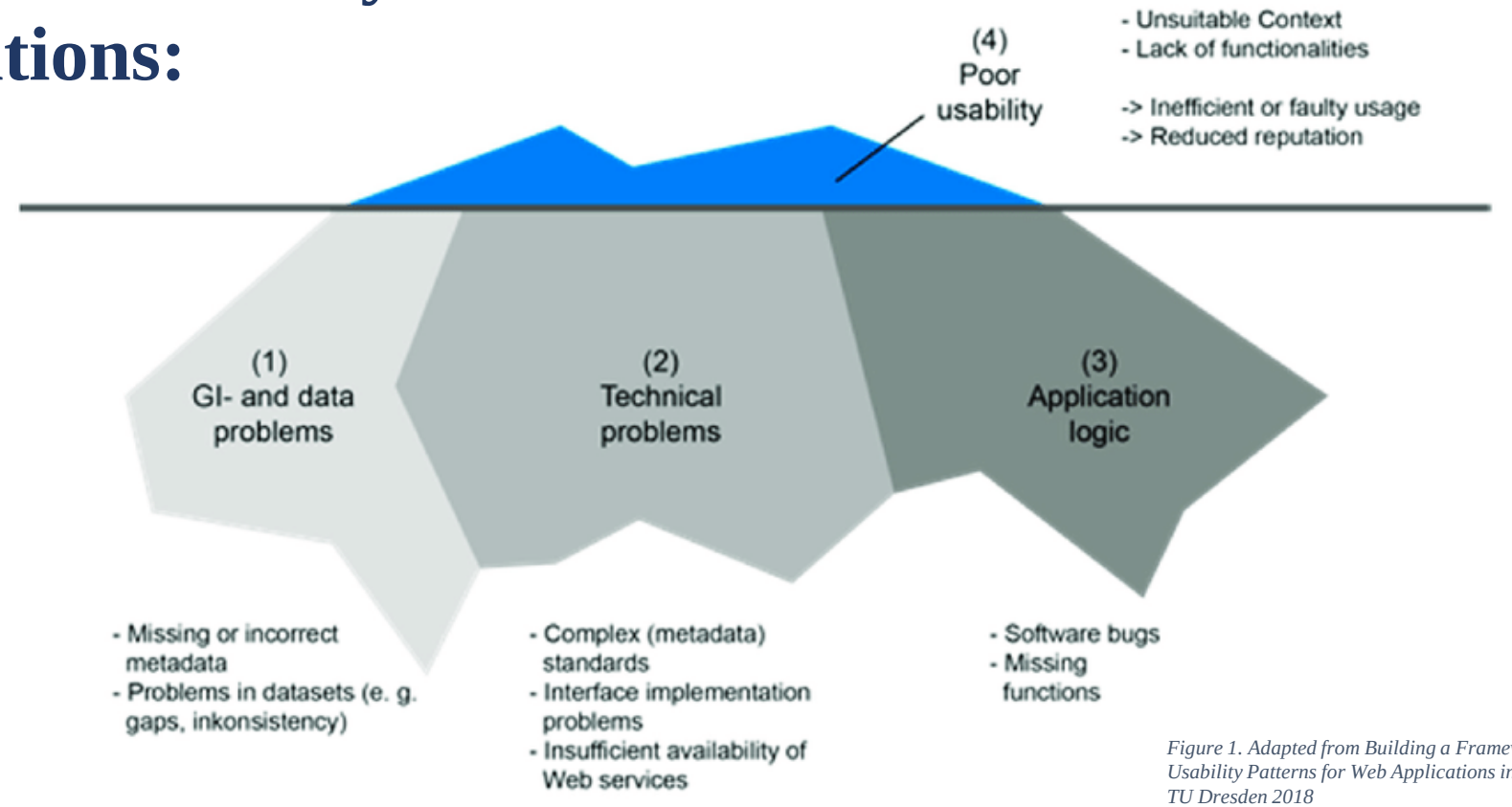


Figure 1. Adapted from Building a Framework of Usability Patterns for Web Applications in SDIs. TU Dresden 2018

- Usability problems are **frequent**
- No methods to summarize these problems
- To provide software independent solutions
- Existing usability patterns DO NOT cover GI Specific problems.

Conclusions

- GIS is provides support for planning and management of resources.
- Useful tool for teaching geographic content.

❖ Historical GIS for Namibia

❖ Advocate for the spatially informed decision making processes.

THANK YOU FOR YOUR ATTENTION!