UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE

Joint 6th Plenary of the UN-GGIM Subcommittee on Geodesy and 4th UN-GGCE IAC and Steering Committee Meetings

Joining Land and Sea

Evert Mulder
Technical Adviser, UN-GGCE

Rationale

Land and sea domains are directly related, but relevant data often fragmented. There is an increasing need for **Foundational Geodetic Data and Products** that are ***Harmonized, Interoperable*** and ***Globally Aligned*.**

The absence of these has implications for:

- Climate resilience related applications and decision making
- Shipping activities and (commercial) use of the intertidal zone
- Land reclamation and engineering projects
- Coastal infrastructure

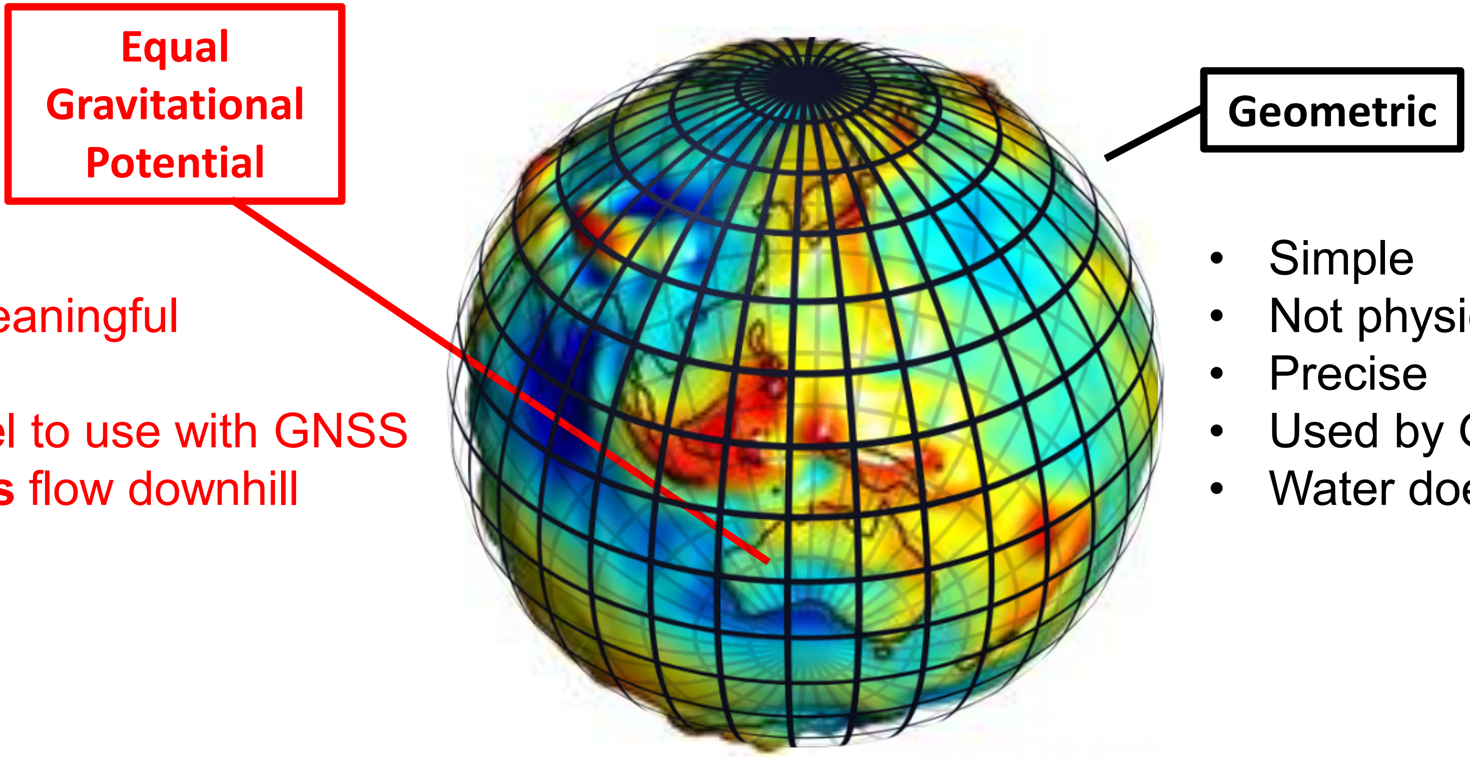
And more..

Heights & Depths
→ *Hard … but Important*

- Which way does water flow, and how can we design effective drainage and sewerage systems in cities?
- How can we develop efficient irrigation systems for agriculture?
- How can we ensure the correct inclination of railways and roads?
- What is the height of the top of a mountain?
- How can we map bathymetry and know the under-keel clearance of a ship?
- How can we monitor sea-level change and accurately model coastal processes such as extreme tides, storm waves, and flooding?

https://www.welt.de/vermischtes/weltgeschehen/gallery9348988/Das-Jahrzehnt-der-Wetterkatastrophen.html

Physical vs Geometric Systems



- Complex
- Physically meaningful
- Precise
- Need a model to use with GNSS
- Water **always** flow downhill

- Simple
- Not physically meaningful
- Precise
- Used by GNSS & Remote Sensing
- Water doesn't always flow downhill

→ *It is important to understand how these are different and how data from these systems can be used together*

Guidance on Joining Land and Sea
UN-GGCE International Workshop Initiative

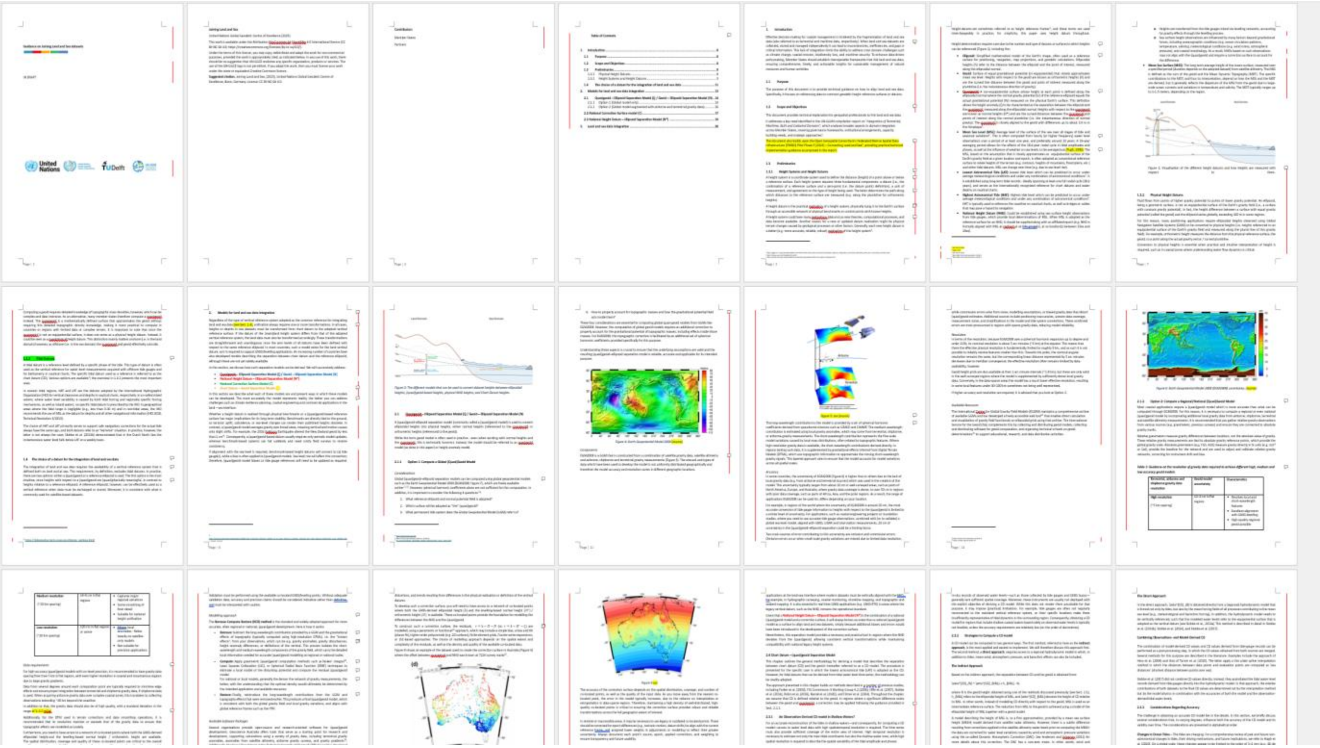
Key Recognitions:

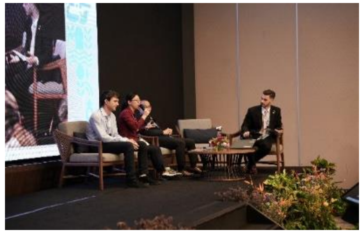
- GGSC is foundational to climate resilience and disaster management
- Need to strengthen capacity, standards and next-generation professionals
- Importance of clear messaging and stronger international networks

Agreed Actions:

- ***Develop practical guidance*** for Member States on integrating land and sea data
- ***Develop communication materials*** to create awareness and explain benefits and policy relevance

Guidance Paper *- Buffering…*





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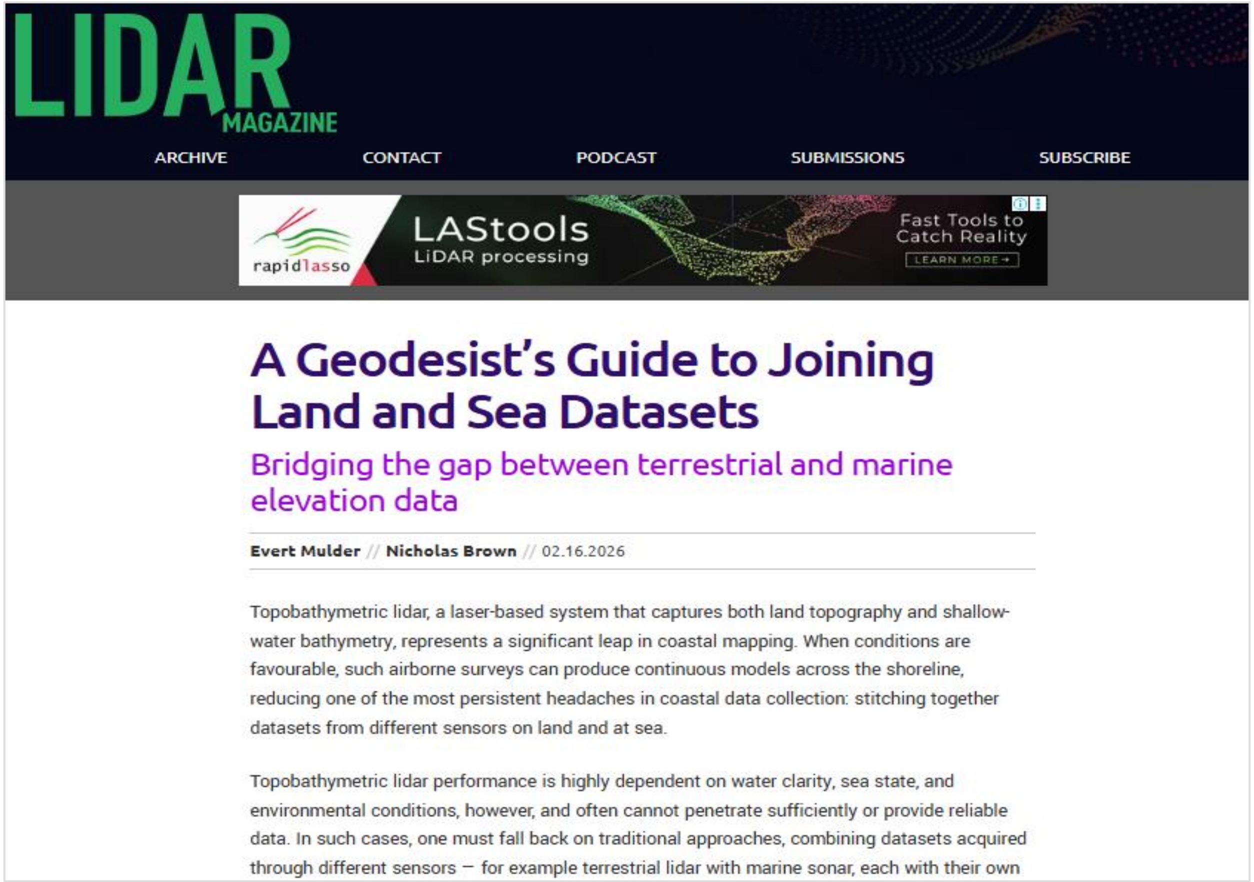
Awareness



LIDAR MAGAZINE

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A Geodesist's Guide to Joining Land and Sea Datasets

Bridging the gap between terrestrial and marine elevation data

Evert Mulder // **Nicholas Brown** // 02.16.2026

Topobathymetric lidar, a laser-based system that captures both land topography and shallow-water bathymetry, represents a significant leap in coastal mapping. When conditions are favourable, such airborne surveys can produce continuous models across the shoreline, reducing one of the most persistent headaches in coastal data collection: stitching together datasets from different sensors on land and at sea.

Topobathymetric lidar performance is highly dependent on water clarity, sea state, and environmental conditions, however, and often cannot penetrate sufficiently or provide reliable data. In such cases, one must fall back on traditional approaches, combining datasets acquired through different sensors – for example terrestrial lidar with marine sonar, each with their own

https://lidarmag.com/2026/02/16/a-geodesists-guide-to-joining-land-and-sea-datasets/

Feedback

Received a lot of great feedback through the various regional Datum Modernization workshops and other discussions/exchanges.

This prompted changes in our approach.

→*Aim is to "do things right".*

Partnership – as a result

UN-GGCE & TU Delft

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Terminology

We adopt ISO terminology from as the primary standard, ensuring alignment with international geospatial conventions.

However, where ISO terminology conflicts with established geodetic practice, e.g., on the distinction between *datums* and *reference frames*, we adopt definitions from authoritative sources such as the International Association of Geodesy (IAG) and classical geodetic literature.

Current Status

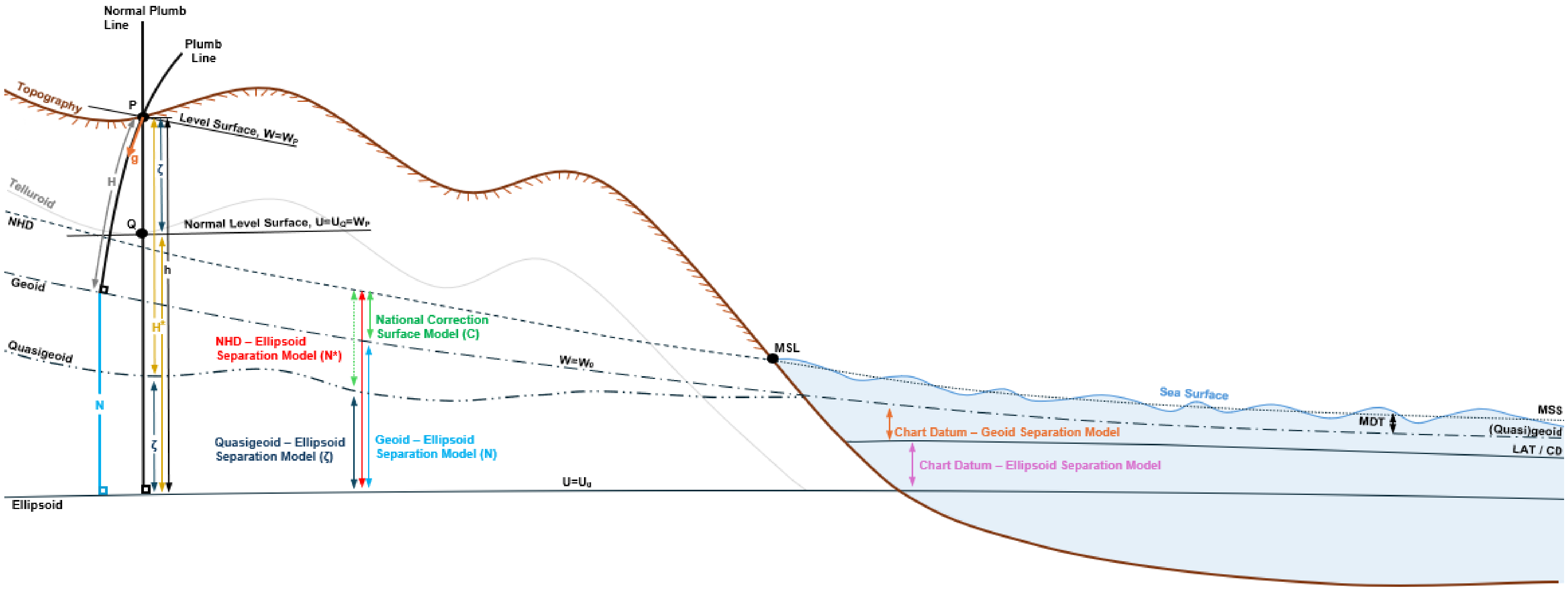
Framework – Subject to change:

1. Introduction
2. Preliminaries - Coordinate Reference Systems: Foundations and Key Concepts
3. Practical Realization of Vertical Coordinate Reference Systems in the Land Domain
4. Practical Realization of Vertical Coordinate Reference Systems in the Sea Domain
5. Land and Sea Domain Integration

In a Visual

Land Domain

Sea Domain

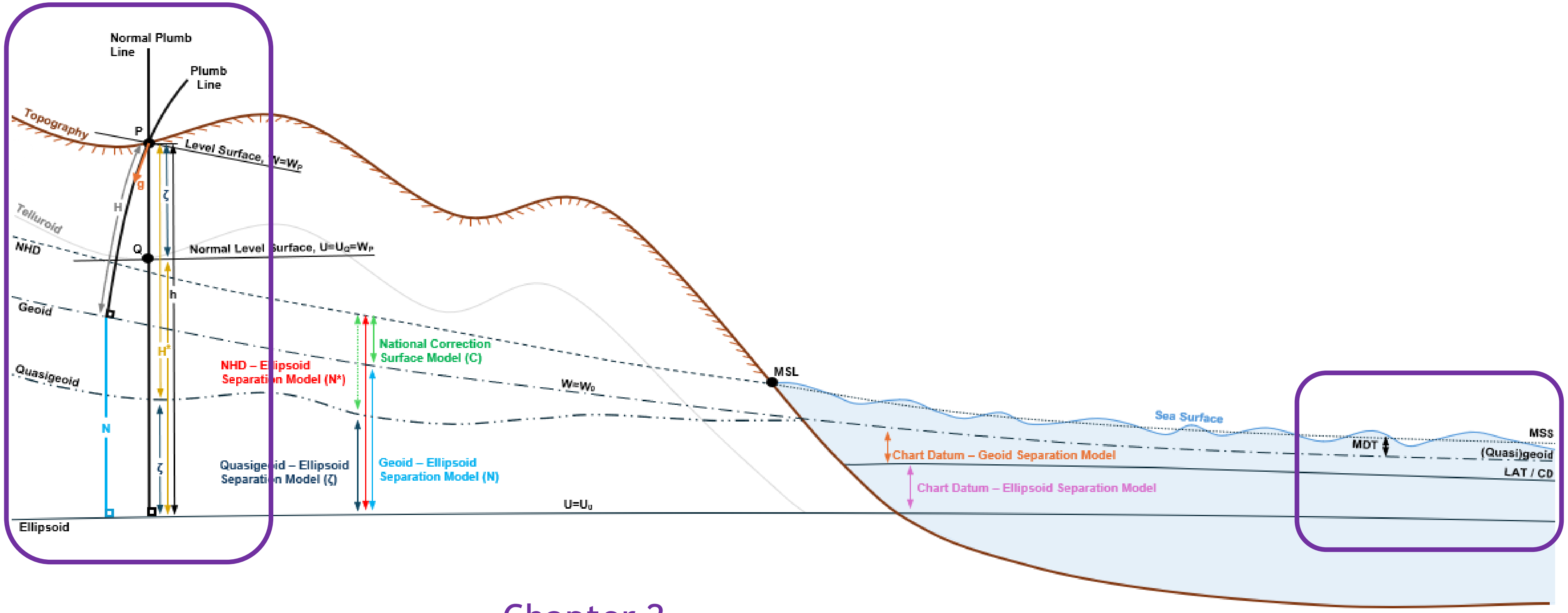


In a Visual

Ch 2. Preliminaries - Coordinate Reference Systems: Foundations and Key Concepts

Land Domain

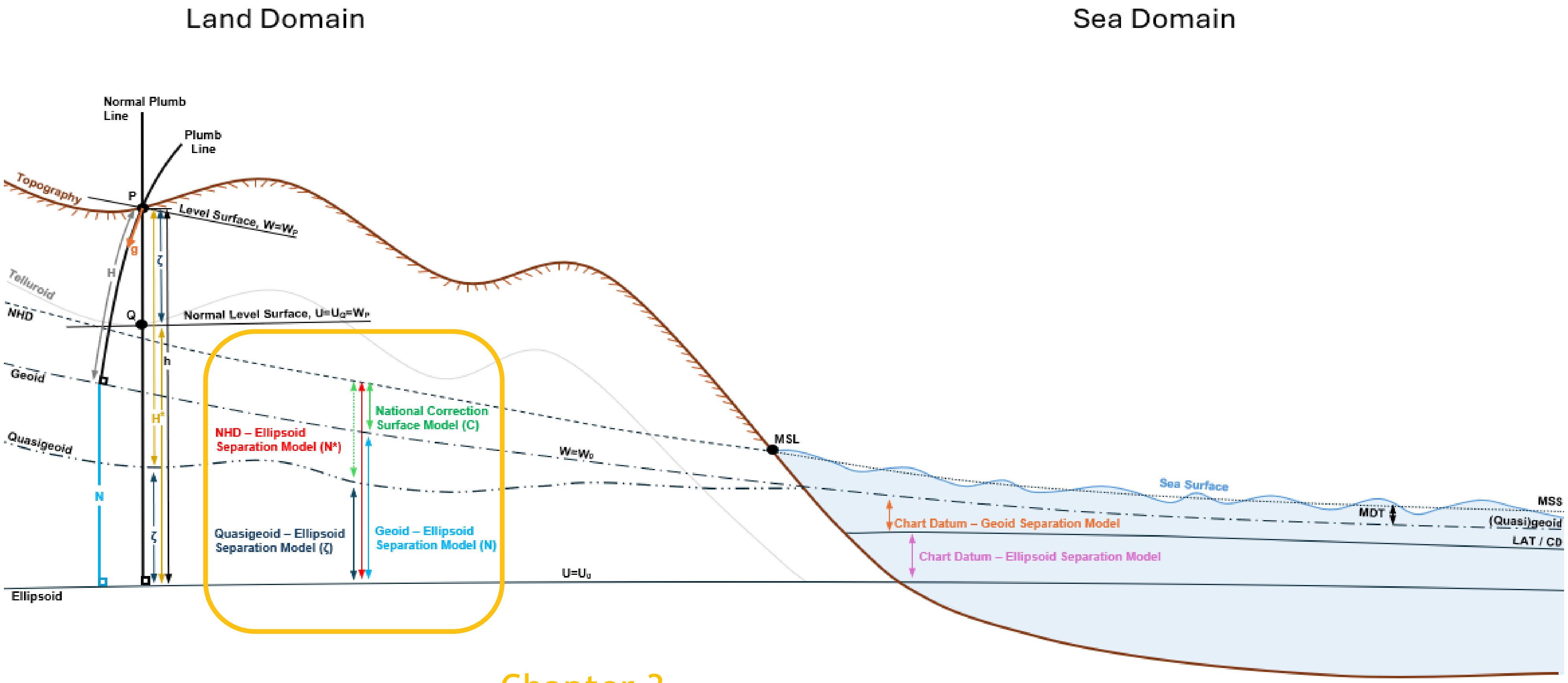
Sea Domain



Chapter 2

In a Visual

Ch 3. Practical Realization of Physical Vertical Coordinate Reference Systems in the Land Domain



Chapter 3

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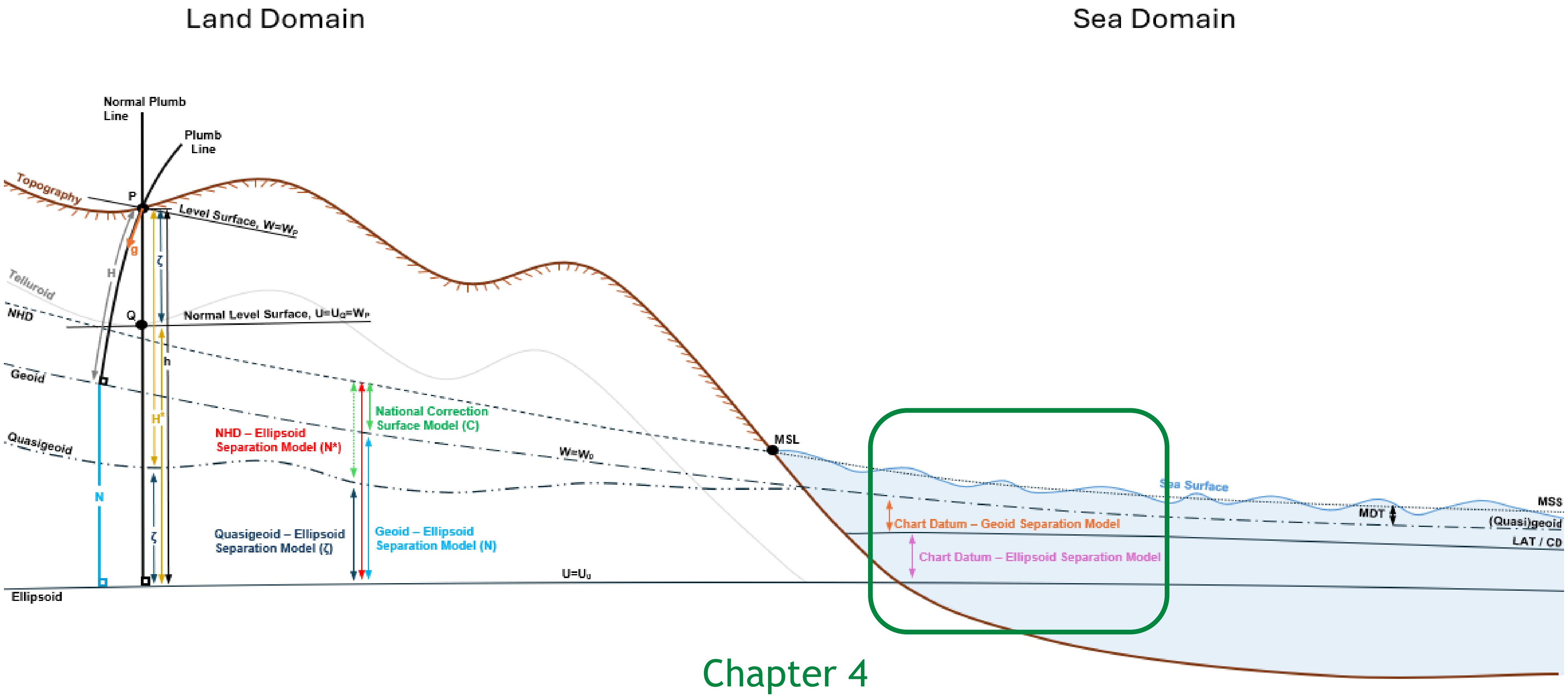
In a Visual

Ch 4. Practical Realization of Physical Vertical Coordinate Reference Systems in the Sea Domain



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The integration

Required:

Vertical reference system defined both on land and at sea.

→ *This, by definition, excludes tidal datums.*

In practice, there are only two options:

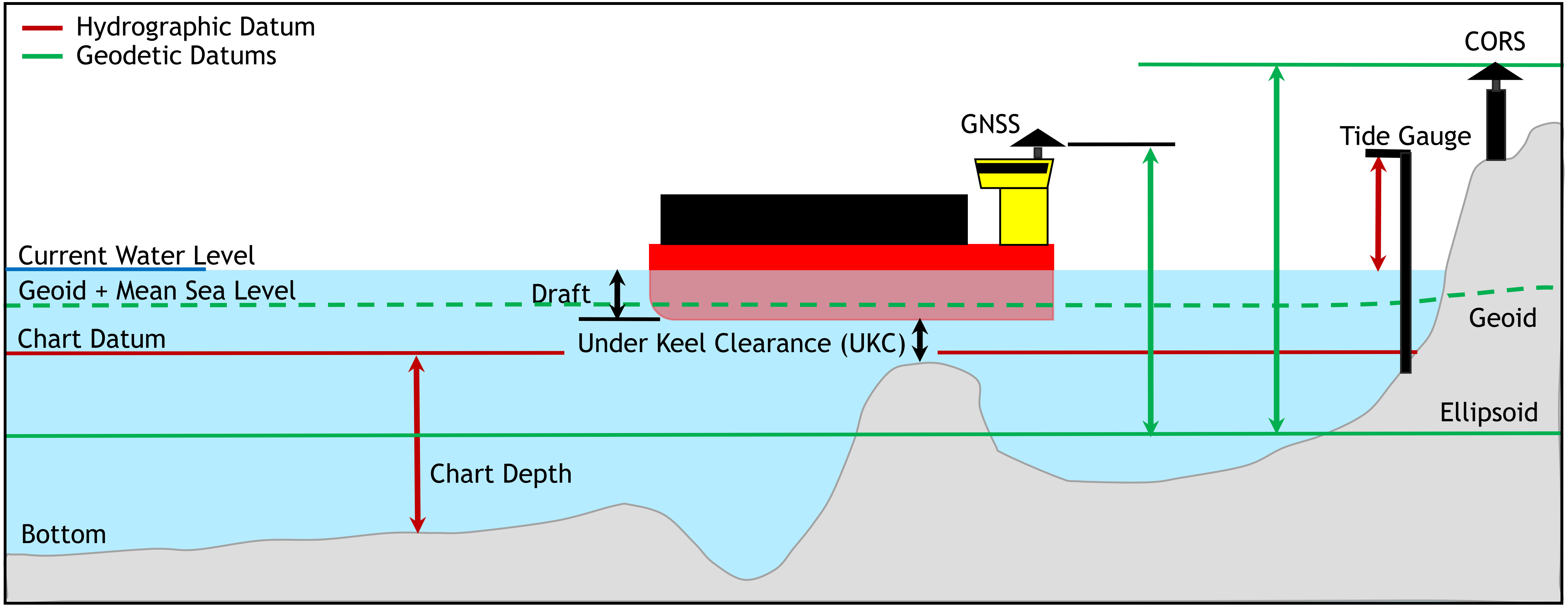
- ***(Quasi)Geoid*** - the most intuitive, since vertical distances relative to it are (quasi)physically meaningful, in contrast to heights relative to a reference ellipsoid.

- ***Reference ellipsoid***, not physically meaningful, but can still serve as a vertical reference when data must be exchanged or stored. Commonly used for satellite-based datasets.

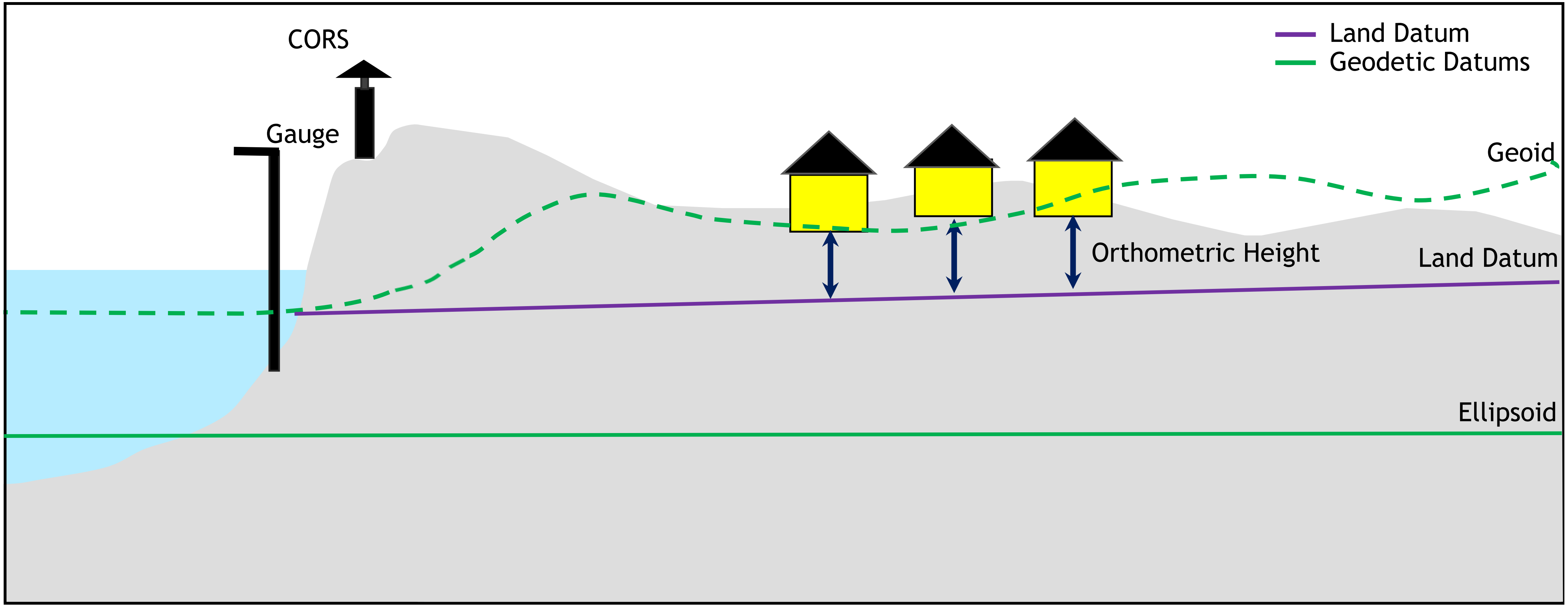
Joining Land and Sea Datasets
→ *Practical Examples*

Dataset	Source	Observed Datum	Conversion to normal heights (H*) / orthometric heights (H) (heights with respect to the quasigeoid or geoid, respectively)	Conversion to National Height Datum (NHD) heights (heights with respect to the NHD)	Conversion to Chart Datum (CD) heights (heights with respect to the CD)
Sea level data	Tide gauge	Tide gauge reference point	• Tide gauges often have an internal reference point which has a known height difference from an external reference point. • It is possible to determine the normal / orthometric height of a tide gauge's external reference point. • This can be done by performing a GNSS observation on a nearby* survey mark, then applying a **Quasigeoid – Ellipsoid Separation Model (ζ)** / **Geoid – Ellipsoid Separation Model (N)** to convert the ellipsoidal height into a normal / orthometric height (depending on the model used). • Levelling can then be used to measure the	• Tide gauges often have an internal reference point which is a known distance from an external reference point. • It is possible to determine the National Height Datum (NHD) height of a tide gauge's external reference point. • This can be done by performing a GNSS observation on a nearby* survey mark, then applying a **National Height Datum – Ellipsoid Separation Model (N*)** to convert the ellipsoidal height into a NHD height. • Levelling can then be used to measure the NHD height difference between this survey mark and the tide gauge's external reference point	• …

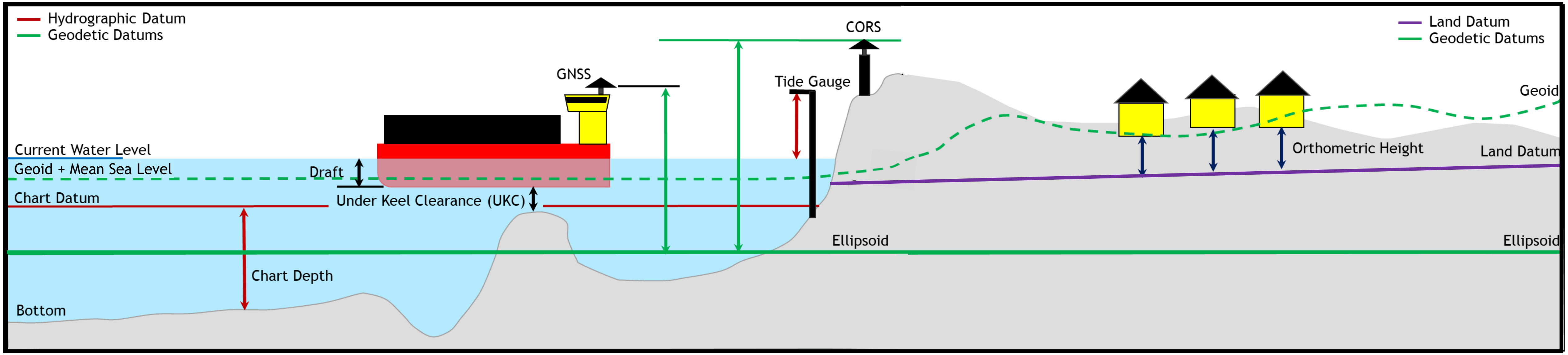
The Sea Domain



The Land Domain



Joining Land and Sea Using Geodesy



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Discussion Points

- Are we on the right track?
- Relevance to you or your member state?
- Anything (else) that we should consider covering specifically?
- Any examples of success stories or good experiences?
- Specific challenges or things that did not go so well?

  → ***Any solutions for those?***

- Specific case studies that are/should be of interest?

Thank You

"Where fragmented depths and heights collide,
geoid-referencing ensures they are seamlessly tied."