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Unveiling the first high resolution satellite mosaic coverage of Botswana's Okavango Delta

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Organization of presentation

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- Origin of the CORONA Programme
- Significance of CORONA photographs
- Location of the Okavango Delta
- CORONA photographs available for the Okavango Delta
- Limitations of CORONA photographs
- Procedures that were used to compile the mosaic
- Final product

Origin & Purpose of the CORONA Programme

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- **CORONA photographs were acquired by the US military in an undercover surveillance program called CORONA to spy on Russia, China and other countries during the Cold War.**
- **The entire programme comprised 144 satellites that were launched between June 1959 and May 1972 and disguised as part of the Discoverer program.**

- **CORONA satellites used special 70 mm film with a 24-inch focal length lens and remained secret until 1992.**
- **Early systems carried a single panoramic camera while later systems used two forward and backward looking cameras designed to provide stereoscopic coverage.**
- **Other secret satellites of the pioneer phases include ARGON and LANYARD**

- **Keyhole (KH) designators: KH-1 to KH-4, KH-4A and KH-4B were used to identify the satellites with incrementing numbers indicating changes in surveillance instrumentation.**
- **KH-1 to KH4 had a spatial resolution of 25ft; KH-4A 9ft; KH-4B 6ft.**
- **CORONA programs were gradually phased out to give way to the GAMBIT programme between 1963 and 1984.**
- **No detailed information on GAMBIT is presently available.**

Significance of CORONA photographs

- For selected areas that were covered, CORONA photographs can extend the temporal coverage of remotely sensed images into the past by nearly a decade prior to the launch of Landsat I in 1972.
- The photographs provide more detail because they can be viewed in stereo at spatial resolutions ranging between 1.8m and 2m

Location of the Okavango Delta

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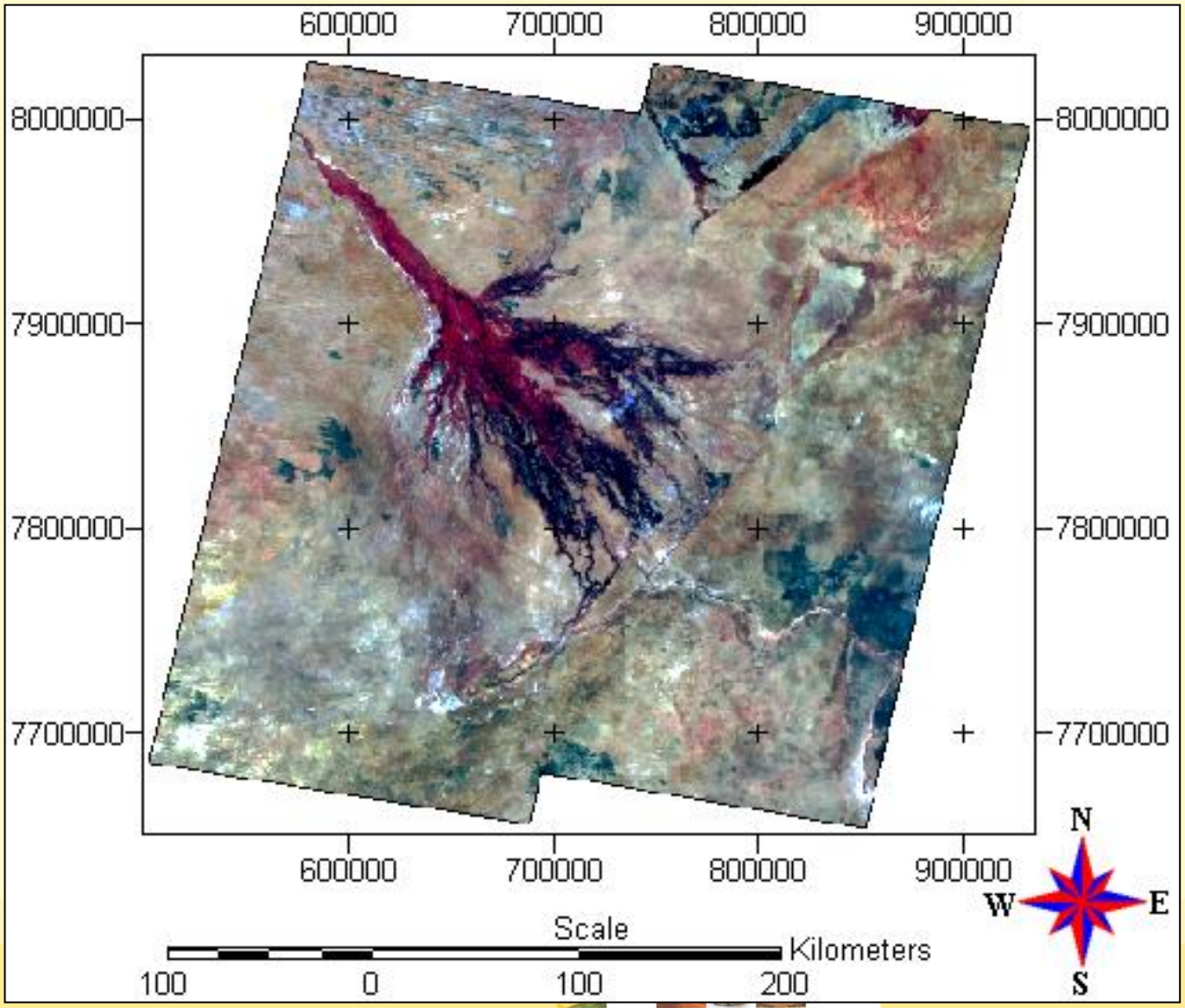

Coverages available for the Okavango Delta

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Footprint of CORONA negatives

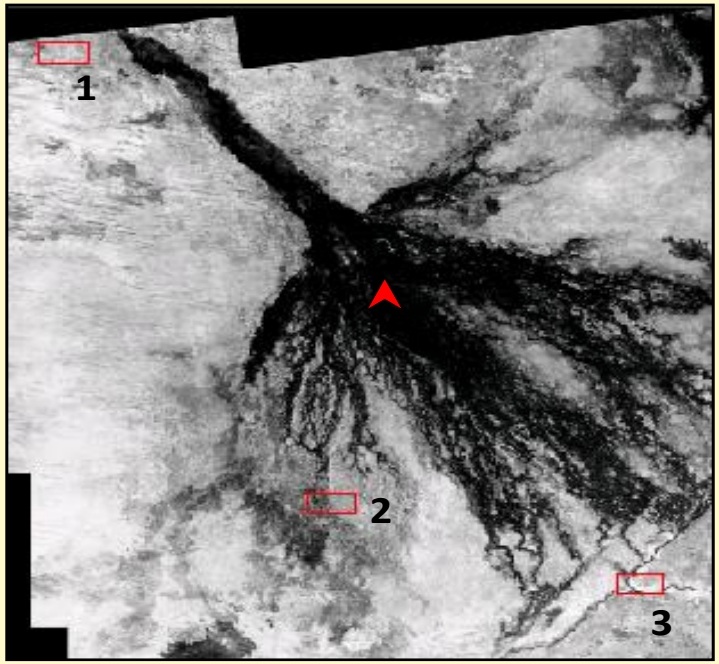
Ordering Identifier	Product description
DS1101-2153DA050	2.25" x 30" Neg Film
DS1101-2153DA051	2.25" x 30" Neg Film
DS1101-2153DA052	2.25" x 30" Neg Film
DS1101-2153DA053	2.25" x 30" Neg Film
DS1101-2153DA054	2.25" x 30" Neg Film
DS1101-2153DA055	2.25" x 30" Neg Film
DS1101-2153DF056	2.25" x 30" Neg Film
DS1101-2153DF057	2.25" x 30" Neg Film
DS1101-2153DF058	2.25" x 30" Neg Film
DS1101-2153DF059	2.25" x 30" Neg Film
DS1101-2153DF060	2.25" x 30" Neg Film
DS1101-2153DF061	2.25" x 30" Neg Film
DS1101-2153DF062	2.25" x 30" Neg Film
DS1101-2153DF063	2.25" x 30" Neg Film
DS1101-2153DF064	2.25" x 30" Neg Film
DS1101-2153DF065	2.25" x 30" Neg Film
DS1101-2153DF066	2.25" x 30" Neg Film

Total area ~69 000 km²

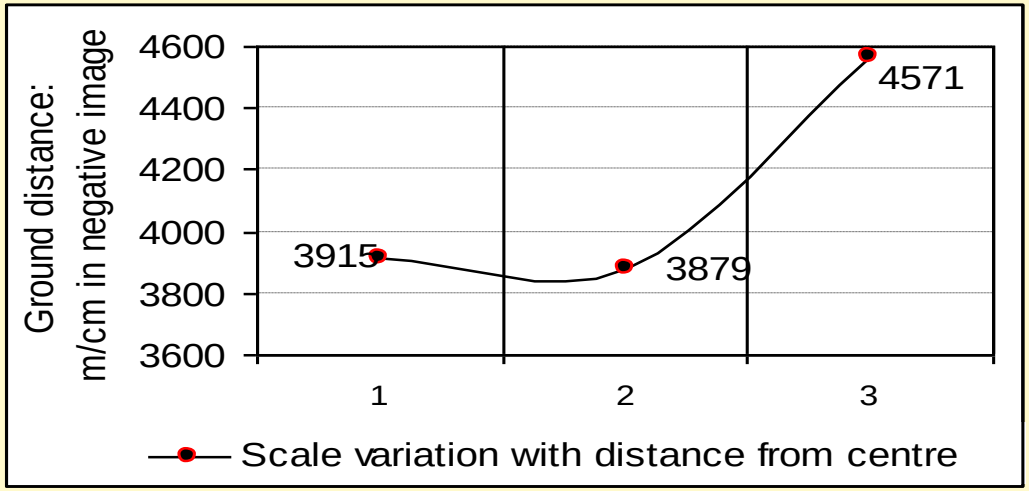
Limitations of CORONA photographs

- Coverage was confined to selected areas of interest.
- Reduced geometric fidelity with radial distortions increasing with distance from the centre of each image frame due to use of panoramic cameras
- Inconsistent overlap due to unstable satellite path & over / underexposure
- Systematic variations in lateral scale due to off-nadir viewing.

Scale variations in negative films



1 1cm in negative film = 3 915 m in rectified image
2 1cm in negative film = 3 879 m in rectified image
3 1cm in negative film = 4 571 m in rectified image



Increasing distortion

Image Centre

Increasing distortion

DISTANCE

Procedures that were used to compile the mosaic

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- Scanning the negative films and inverting the scanned sub-sets
- Georeferencing & colour balancing.
- Trimming over-warped edges.
- Correcting discordance in linear features.
- Mosaicking the adjacent strips.

Figure 3 georeferencing

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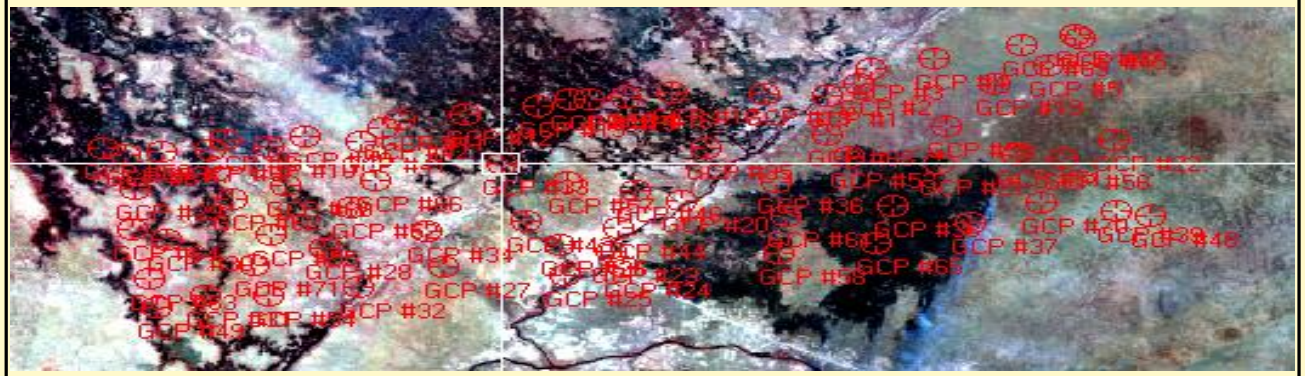
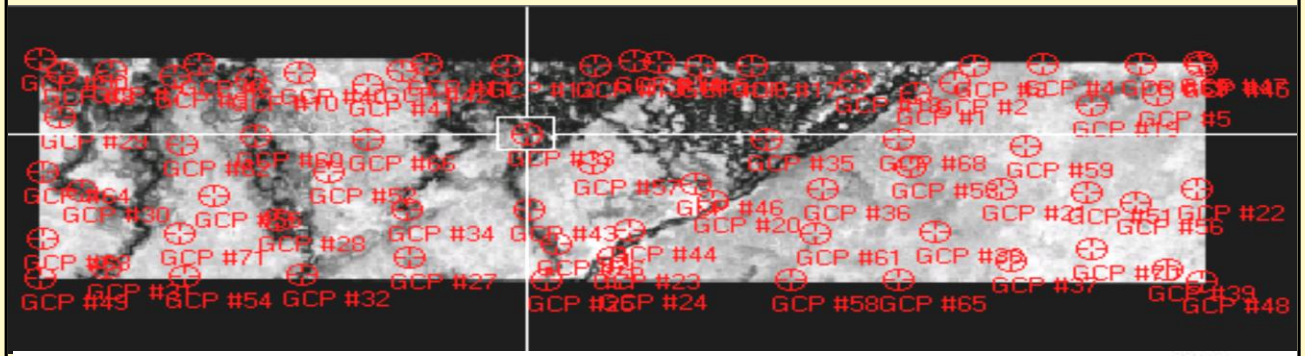
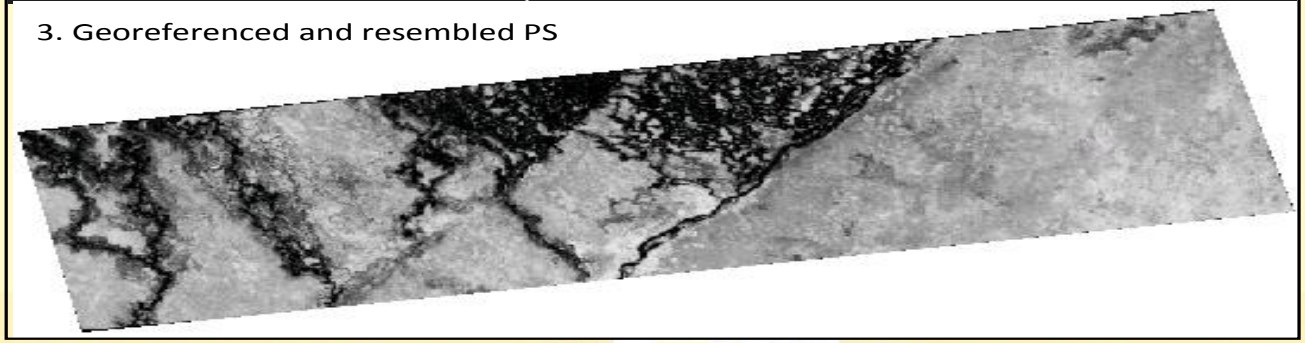
1. Primary Reference Image [PRI]: Initial source of control points



2. The Primary Strip [PS]: First subset to be corrected



3. Georeferenced and resembled PS



Trimming warped edges

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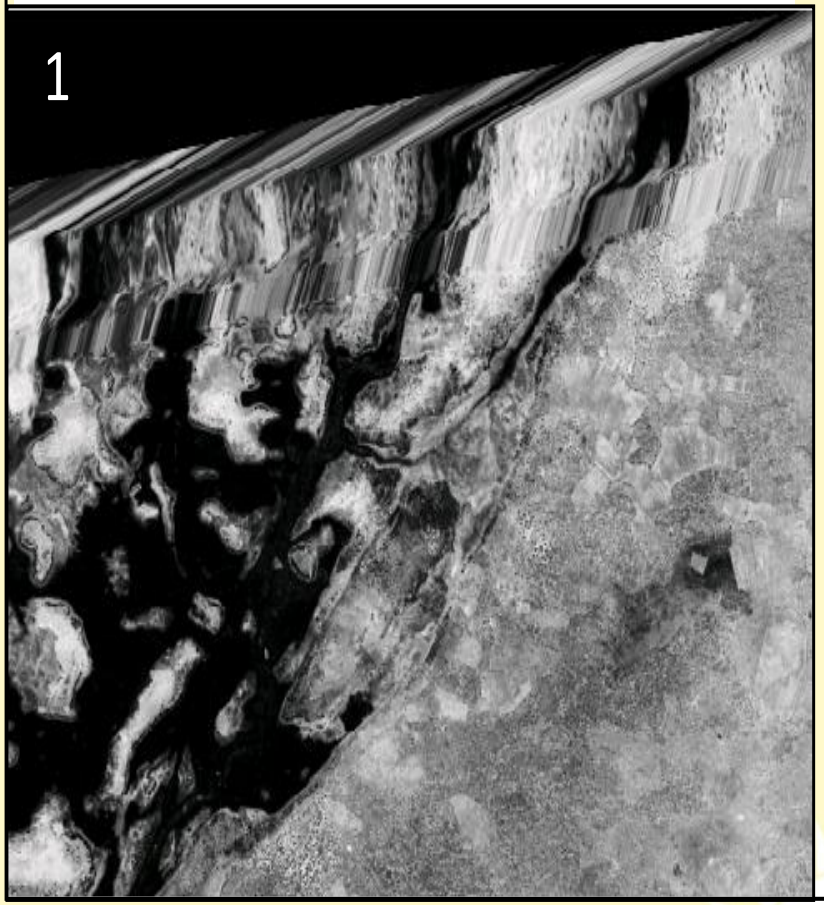
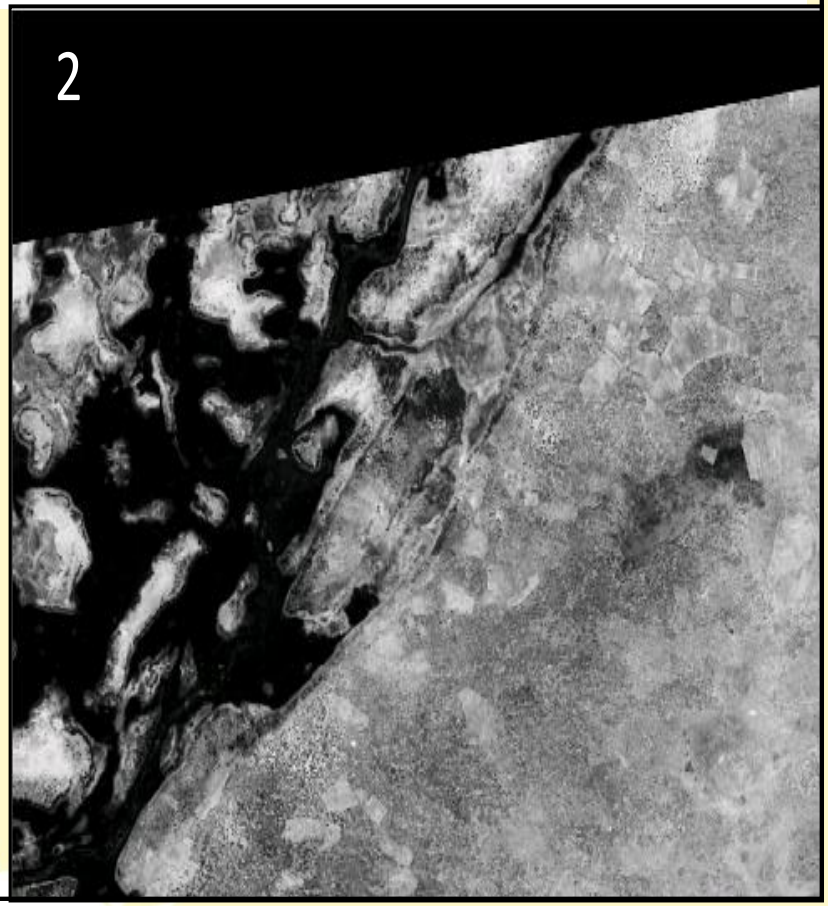
Before warped edges are trimmed

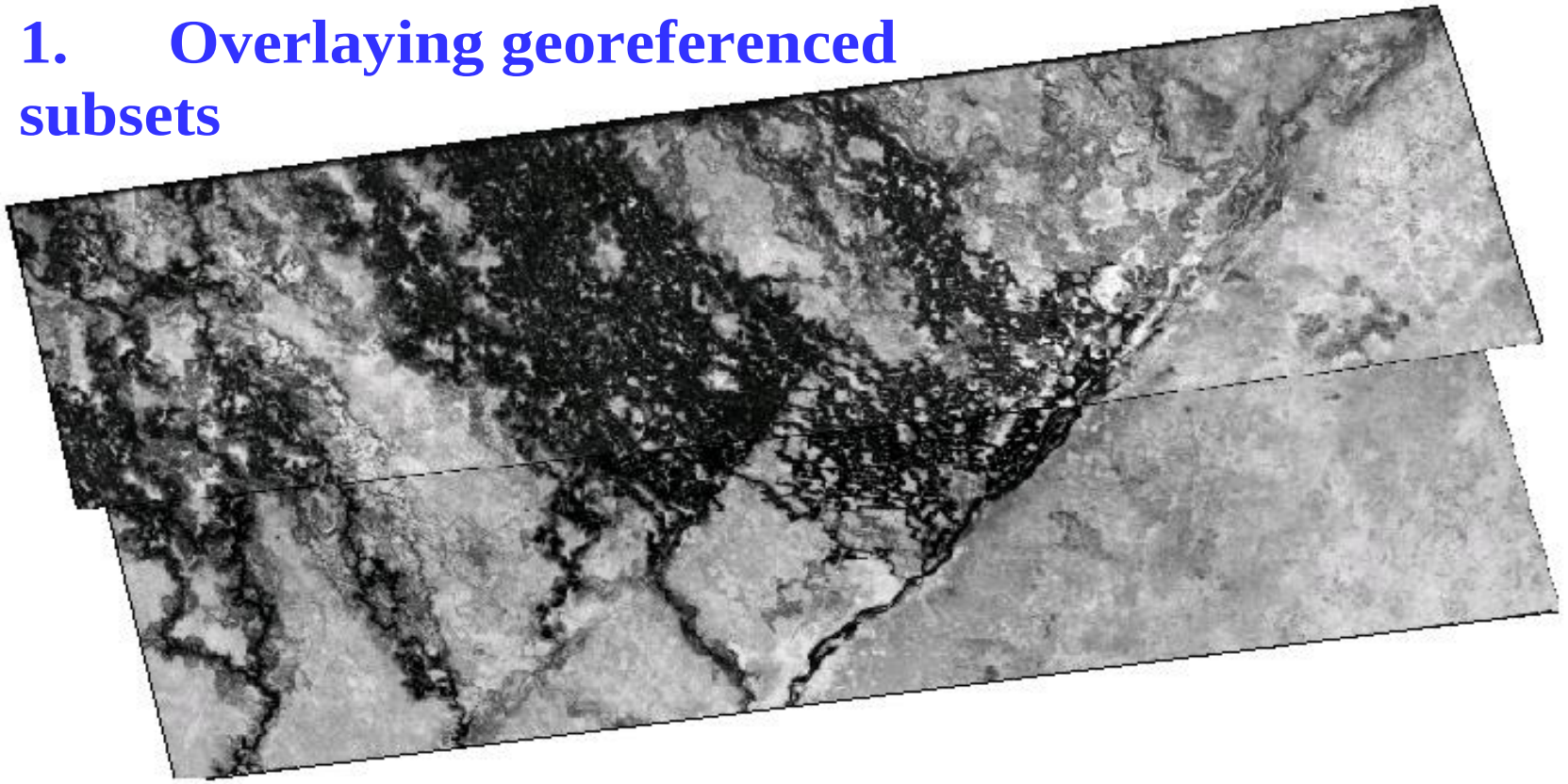


After warped edges are trimmed



Correcting errors

1. Overlaying georeferenced subsets



2. Checking distortions and correcting linear errors.

Successive overlaying & mosaicking

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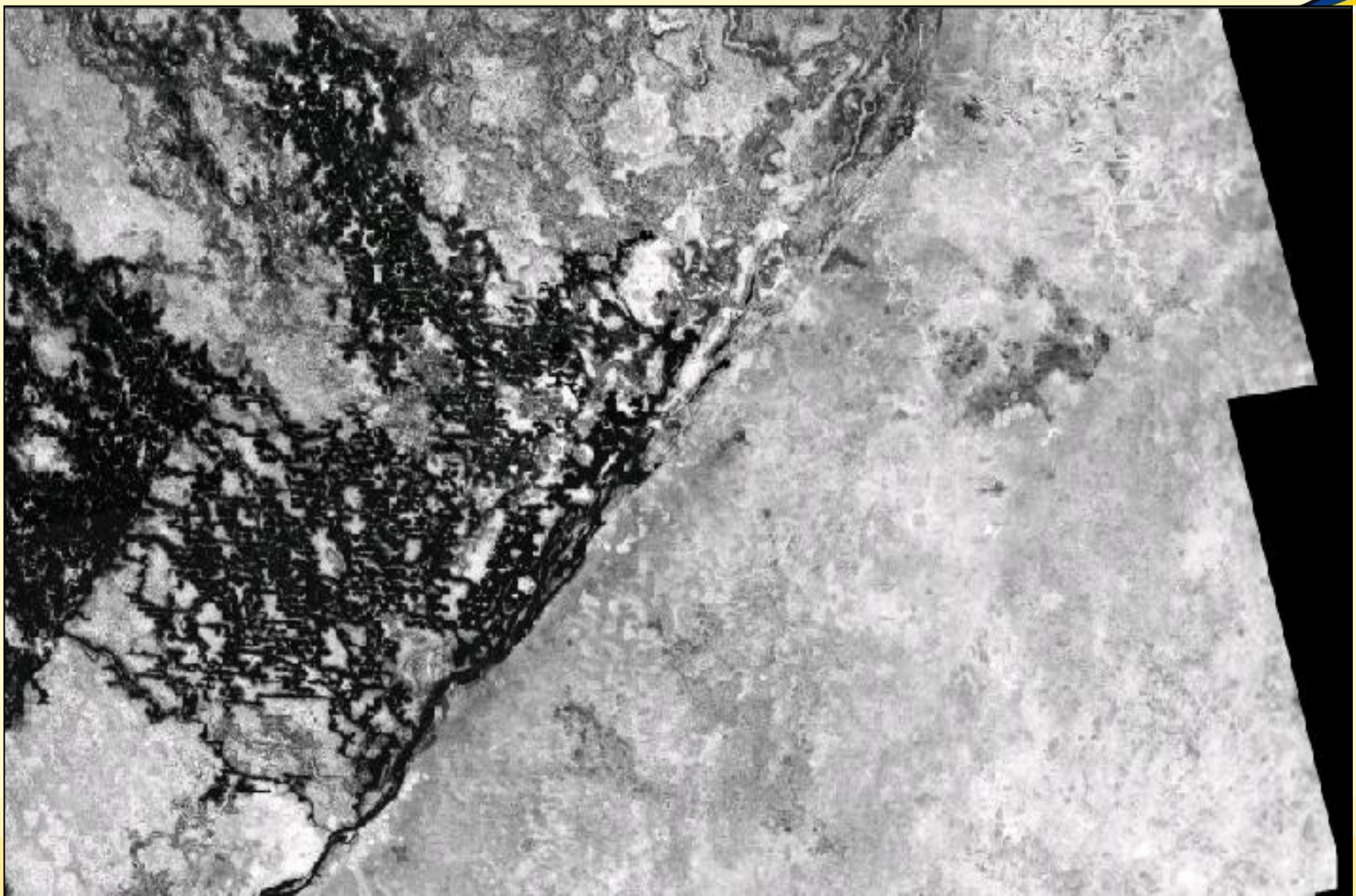
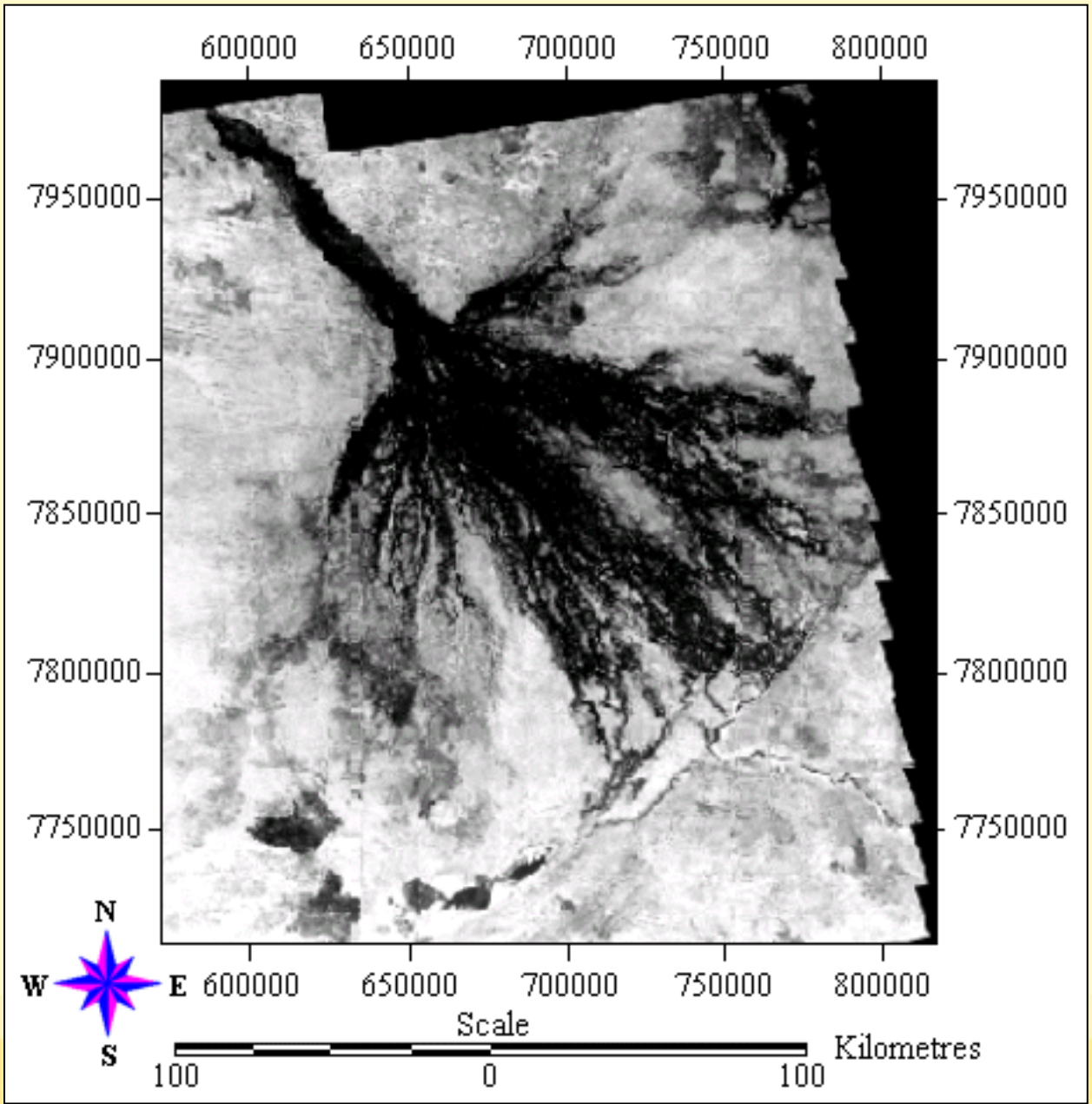


Final product



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Disk Space: ~38 GB

References

1. **Hamandawana, H.,** Eckardt, F., Ringrose, S., 2007. Proposed methodology for georeferencing and mosaicking CORONA photographs. International Journal of Remote Sensing 28(1), 5-22.
2. **Hamandawana, H.,** Eckardt, F., Ringrose, S. 2006. The use of step-wise density slicing in classifying high-resolution panchromatic photographs. International Journal of Remote Sensing 27(21), 4923-4942.
3. **Hamandawana, H.,** Eckardt, F., Chanda, R. 2005. Linking archival and remotely sensed data for long-term environmental monitoring. International Journal of Applied Earth Observation and GeoInformation 7(4), 284-298.

Acknowledgments

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