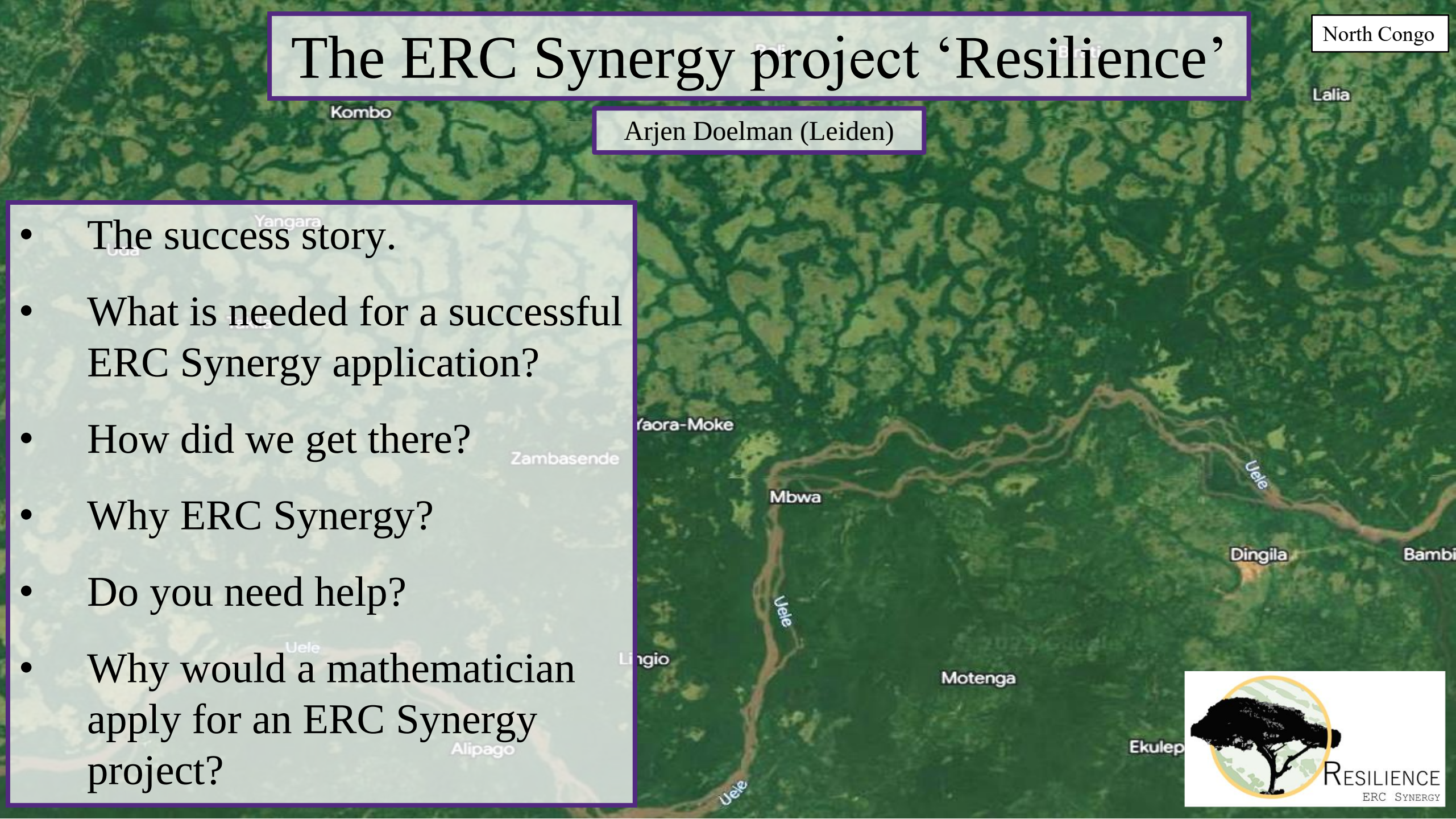
The ERC Synergy project ‘Resilience’

Arjen Doelman (Leiden)

North Congo

- The success story.
- What is needed for a successful ERC Synergy application?
- How did we get there?
- Why ERC Synergy?
- Do you need help?
- Why would a mathematician apply for an ERC Synergy project?



Utrecht University

Spatial ecology

Max Rietkerk

Arjen Doelman

Dynamical systems

Universiteit Leiden
The Netherlands

European Commission

RESILIENCE

erc
European Research Council
Established by the European Commission

- The success story.

THE UNIVERSITY of EDINBURGH

Global change ecology

Isla Myers-Smith

Ehud Meron

Pattern formation

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Ben-Gurion University of the Negev

Utrecht University

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The Netherlands

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RESILIENCE Summary

Pressing question
- How to evade and reverse ecosystem tipping?

Innovative aspects and transformation
- Novel concept of multi-stability.
- New pathways to resilience.
- Novel human intervention.

New!

Prospect solutions for next generation!

Synergy guaranteed
- Fully integrated pillars: ecology, mathematics, physics, computing, data.
- Real new cross-disciplinary collaboration in all WP's, based on solid ground.

- What is needed for a successful ERC Synergy application?

- A compelling research question.
- A qualified research team that transcends the sum of its members (*i.e.*, there is ‘added value’ in bringing these individuals together).
- A ‘proof’ that the members of the team can work truly together (*i.e.*, there must be some kind of track record).

Note: there’s some ‘tension’ between these two bullets: it’s hard to claim true added value when a team has a long collaboration history.

- There should be some ‘spread’ in the research fields of the team members.

In principle 4 mathematicians could work, but not all 4 in the same subfield.

- The research should go beyond ‘business as usual’ for the team members.

• How did we get there?

The Arjen Doelman (Leiden, math) – Max Rietkerk (Utrecht, ecology) collaboration

- First contact: Odo Diekmann.
- AD already studied models that were also ‘cooked up’ within the ecology-community
  (my first contribution: what you call the Klausmeier model = the Gray-Scott model from chemistry)
- A successful joint *Complexity* project: 2 PhD students (1 Leiden/1 Utrecht) who collaborated intensively together → **the team truly collaborated as a team**.
  (crucial ingredient: AD could bike from Utrecht train station to home via the UU campus!).
- A successful *Mathematics of Planet Earth* project (1 (truly) joint Leiden-based student).
- A successful *NWO Open Competition* project: 2 PhD students (1 Leiden/1 Utrecht).

But also

- An unsuccessful ERC Advanced Grant application (AD).
- An unsuccessful ‘Zwaartekracht’ project.

Bringing in Ehud Meron (*physics*) & Isla Myers-Smith (*observational ecology*)

- Internationally acclaimed leaders in their fields.

  → nonlinear physics & arctic observations (tundras)

- EM has lots of overlap with MR, no joint papers, 1 joint project with AD (1 joint paper).
- IMS + MR: observational foundation (tundras & savannas)
- AD + EH: theoretical foundation (dynamical systems & pattern formation)
- EH + MR (& a bit AD): modelling (almost no models for tundras ↔ physical processes).

  Like AD & MR, EH was very much interested in the extension to northern ecosystems.

  ISM was very much interested in the new theoretical foundation of her observations.

  AD was looking for observational confirmations & challenges of the theory.

  MR longed for a team effort to understand 'the evasion of tipping' (or not).

  } enthusiasm

- Synergy

• Why an ERC Synergy?

ERC Advanced Grant ‘Singular Patterns – Interactions, Deformations & Inhomogeneities’

Well-received,

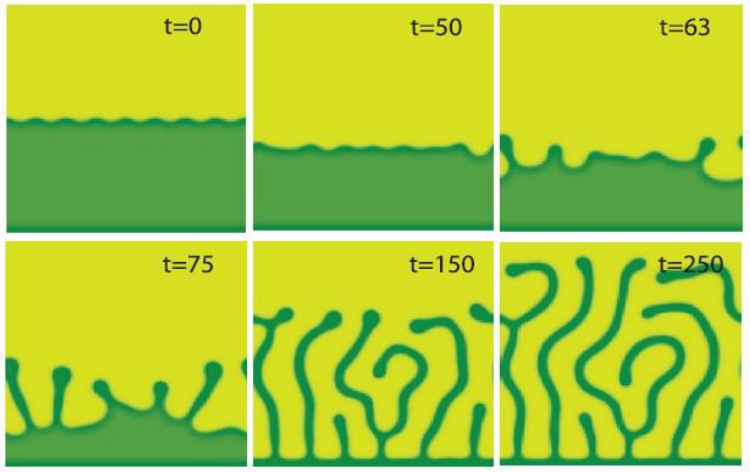
(Warning: reviews by mathematicians are typically ‘too positive’ …)

Understanding pattern formation and evolution in nonlinear systems is a challenging problem in which many issues are still unresolved. The proposal makes a very strong case for the proposed approach on the interaction and deformation of patterns. The description of the state of the art and in particular the role of the spectral gap and the more recent use of modulated patterns is excellent. How the project will go beyond the state of the art on these topics has been nicely emphasized. Analyzing the impact of essential spectrum in going beyond the standard spectral gap assumption in the one-dimensional analysis and the introduction of novel classes of free boundary problems in the two-dimensional analysis are particularly intriguing aspects of the proposal. The aims of the proposal are clearly novel and challenging.

‘*You should certainly resubmit*’ – I may do so (with an ‘update’), ‘sometime in the future’.

However, I followed the strong (& very correct) advice: *Only write about the mathematical motivation & embedding of the planned research, anything beyond that will be considered as a weakening of the proposal* (‘Will not be appreciated by the committee’).

- Example 1. The curvature driven evolution of interfaces is a well-established research field of mathematics that builds nice & deep interactions between analysis & geometry.
- However, all fundamental research (often implicitly) assumes that the interface is stable against 'transversal perturbations' – this is quite unnatural from an applied point of view.
- Literature: [Meron et al., 2019], *PRL*, Front Instabilities Can Reverse Desertification.



- It is 'unnatural' to not be able to go into the ecologically motivated aspects of 'transversally unstable evolving interfaces' (curvature is only one of the driving terms).

Why sideband unstable?

- Example 2. Within mathematics, pattern formation is almost exclusively studied in the setting of homogeneous systems. In ecological terms: '*In my dryland it always rains everywhere*' and '*My ecosystem does not have a topography*' (the Netherlands!).

The nature of ecosystem models

→ Inhomogeneous systems, but how to convincingly & mathematically motivate their nature?

→ Let's first try an ERC Synergy with Max (although our chances will be small).

- Do you need help? [Yes, you do!]

- The financial aspects. [Obviously]
- An experienced ‘outside reader’ who knows what’s expected at the ERC.

- Also the ‘*Only write about the mathematical motivation & embedding of the planned research, anything beyond that will be considered as a weakening of the proposal*’-advice was extremely useful (& thus very correct).

(This ‘reader’ was recommended by Aad van der Vaart & Frank den Hollander – both successful within ERC AdG.)

- The interview! ERC Synergy applicants are interviewed as team ‘live’ in Brussels: *How do they interact? Is it truly a team?*

- Training sessions in Leiden and in Utrecht.

- Experience with ‘Zwaartekracht’- interview extremely useful.

(Quality & commitment of ERC Synergy committee $\gg$ NWO’s ‘Zwaartekracht’ committee ….)

- Let the text be read (& commented upon) by colleagues & (especially) friends.

• Why would a mathematician apply for a ERC Synergy project?

Within mathematics/among mathematicians.

- Mathematics ‘blooms’ around unexpected connections between (sub)fields.

(analysis & probability, number theory & statistics, dynamical systems & geometry, …)

Beyond mathematics (my personal ‘hobbyhorse’).

- There is a huge demand for mathematics/mathematicians in (what we call) ‘applications’.

(ecology, climate science, the earth, life, medical sciences, (physics, astronomy, computer science), sociology, economics …)

- Interactions with ‘applications’ drive the development of mathematics.

What is needed?

- Being open & truly interested. Being eager to learn really new ‘stuff’.
- Flexibility (on both/all sides). Communication!
- Time!

A common trait among/ a driving force for many mathematicians