

# VU Research Portal

## **Narratives of an uncertain future**

Moreno Dumont Goulart, Henrique

2025

**DOI (link to publisher)**  
[10.5463/thesis.927](https://doi.org/10.5463/thesis.927)

**document version**  
Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

### ***citation for published version (APA)***

Moreno Dumont Goulart, H. (2025). *Narratives of an uncertain future: Storylines to connect extreme weather events to impacts and decision making*. [PhD-Thesis - Research and graduation internal, Vrije Universiteit Amsterdam]. <https://doi.org/10.5463/thesis.927>

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

**E-mail address:**  
[vuresearchportal.ub@vu.nl](mailto:vuresearchportal.ub@vu.nl)

---

# Contents

---

<b>Summary</b>	<b>11</b>
<b>Samenvatting</b>	<b>15</b>
<b>1 Introduction</b>	<b>19</b>
1.1 Extreme events and society . . . . .	19
1.2 Climate projections and risk assessment . . . . .	21
1.3 Physical climate storylines . . . . .	22
Impact modelling . . . . .	23
Risk estimation . . . . .	24
Compound events and climate variability . . . . .	24
Adaptation planning . . . . .	25
1.4 Main goal and research questions . . . . .	25
1.5 Reading guide . . . . .	26
<b>2 Storylines of weather-induced crop failure events under climate change</b>	<b>29</b>
2.1 Introduction . . . . .	31
2.2 Data and methods . . . . .	34
2.2.1 Weather and crop data . . . . .	34
2.2.2 Data aggregation and detrending . . . . .	35
2.2.3 Training and validation of the random forest model . . . . .	36
2.2.4 Exploration of global warming scenarios . . . . .	38
2.2.5 Development of storylines . . . . .	39
2.3 Results . . . . .	39
2.3.1 Feature evaluation and selection . . . . .	39
2.3.2 Random forest model evaluation . . . . .	41
2.3.3 Scenario exploration . . . . .	42
2.3.4 Storyline analysis: the 2012 season and future analogues . . . . .	44
2.4 Discussion . . . . .	46
2.5 Conclusion . . . . .	50
2.6 Code availability . . . . .	50
2.7 Data availability . . . . .	51
2.8 Acknowledgements . . . . .	51
<b>3 Increase of simultaneous soybean failures due to climate change</b>	<b>53</b>
3.1 Plain Language Summary . . . . .	54
3.2 Introduction . . . . .	54
3.3 Methods . . . . .	56
3.3.1 Study area . . . . .	56

3.3.2	Climate and crop data . . . . .	56
3.3.3	Data processing and dynamic calendar . . . . .	57
3.3.4	Hybrid model development . . . . .	58
3.3.5	Investigating the risk of future failures . . . . .	58
3.4	Results . . . . .	59
3.4.1	Hybrid model performance and simulation of the 2012 event . . . . .	59
3.4.2	Number of future impact analogue events . . . . .	59
3.4.3	Impact analogues in adaptation scenario . . . . .	61
3.4.4	Country-level analogues . . . . .	62
3.5	Discussion . . . . .	64
3.6	Conclusion . . . . .	67
3.7	Open Research . . . . .	68
3.8	Acknowledgements . . . . .	68
<b>4</b>	<b>Compound flood impacts from Hurricane Sandy on New York City in climate-driven storylines</b>	<b>71</b>
4.1	Introduction . . . . .	72
4.2	Data and methods . . . . .	74
4.2.1	Case study . . . . .	74
4.2.2	Alternative event storylines . . . . .	74
	Climate scenarios: spectrally nudged storylines . . . . .	74
	Sea level rise scenarios . . . . .	75
	Maximised precipitation scenarios . . . . .	76
4.2.3	Modelling framework . . . . .	76
	Tides and storm surges modelling . . . . .	76
	Compound coastal flooding modelling . . . . .	77
	Societal impact modelling: critical infrastructure data and exposure . . . . .	77
4.3	Results . . . . .	78
4.3.1	Alternative meteorological event realisations and climate change scenarios . . . . .	78
4.3.2	Flood hazards . . . . .	80
4.3.3	Evaluation of sea level rise scenarios . . . . .	80
4.3.4	Evaluation of maximised precipitation scenarios . . . . .	80
4.3.5	Critical Infrastructure exposure . . . . .	84
4.4	Discussion . . . . .	84
4.5	Conclusion . . . . .	87
4.6	Code availability . . . . .	88
4.7	Data availability . . . . .	88
4.8	Acknowledgements . . . . .	88
<b>5</b>	<b>Exploring coastal climate adaptation through storylines: Insights from Cyclone Idai in Beira, Mozambique</b>	<b>91</b>
5.1	Introduction . . . . .	93
5.2	Results . . . . .	94
5.2.1	Flood impacts from Idai in Beira substantially increase with climate change and spring tides . . . . .	94

5.2.2	The Integrated strategy reduces flood impacts more than the Hold the Line strategy . . . . .	97
5.3	Discussion . . . . .	98
5.3.1	Insights of using storylines for coastal adaptation in Beira . . . . .	98
5.3.2	Validation of simulations . . . . .	100
5.3.3	Limitations and contextualisation . . . . .	101
5.3.4	Storylines for decision making on adaptation . . . . .	102
5.4	Experimental procedures . . . . .	103
5.4.1	Resource availability . . . . .	103
	Lead contact . . . . .	103
	Materials availability . . . . .	103
	Data and code availability . . . . .	103
5.4.2	Overview . . . . .	103
5.4.3	Case study . . . . .	104
5.4.4	Hydrometeorological scenarios . . . . .	104
5.4.5	Adaptation strategies . . . . .	105
5.4.6	Modelling framework . . . . .	106
	Meteorological data and evaluation . . . . .	106
	Compound coastal flooding modelling . . . . .	106
	Impact modelling . . . . .	106
<b>6</b>	<b>Synthesis &amp; Outlook</b>	<b>111</b>
6.1	Key research questions . . . . .	112
6.2	Remaining scientific challenges and ways forward . . . . .	116
	Making storylines more relevant . . . . .	116
	Improving decision making for storylines . . . . .	117
6.3	Societal context and policy implication . . . . .	118
	<b>Appendices</b>	<b>121</b>
2.A	Additional performance metrics . . . . .	123
2.B	Extrapolation test . . . . .	123
2.C	Supplementary figures . . . . .	125
3.A	Introduction . . . . .	139
3.A.1	Rainfed soybeans . . . . .	139
3.A.2	Coefficient of determination . . . . .	139
3.A.3	Hybrid model potential for regionalization . . . . .	139
4.A	Supplemental figures . . . . .	147
5.A	Supplemental Figures . . . . .	153
5.B	Supplement on informal settlements . . . . .	155
5.B.1	Impacts in informal settlements . . . . .	155
5.B.2	Adaptation strategies in informal settlements . . . . .	155
5.C	Supplemental experimental procedures . . . . .	156
5.C.1	Model parameters . . . . .	156
	<b>List of Publications</b>	<b>159</b>
	<b>References</b>	<b>183</b>

**Acknowledgements** 185

**About the Author** 189