BANKING REGULATION AND SUPERVISION AGENCY

BDDK

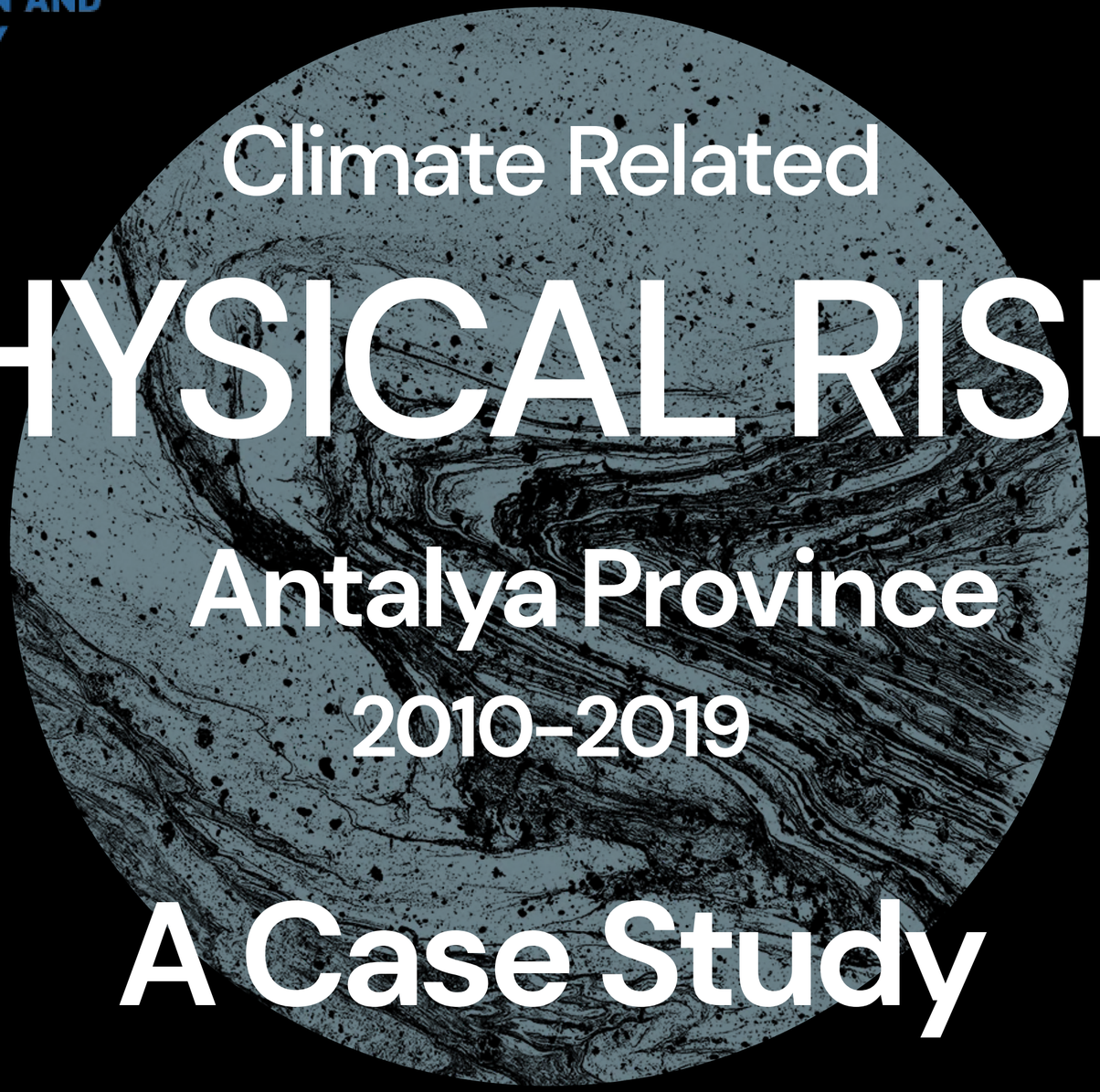
Climate Related

PHYSICAL RISKS

Antalya Province

2010–2019

A Case Study



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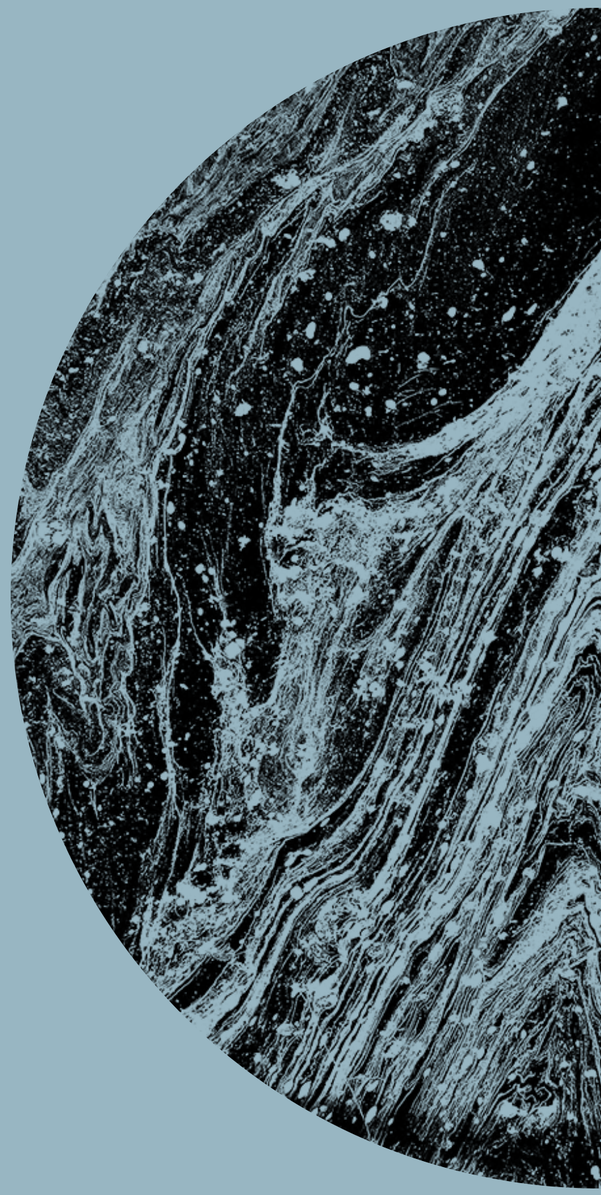
Background



References

(1) Central banks, financial supervisors and financial institutions should;

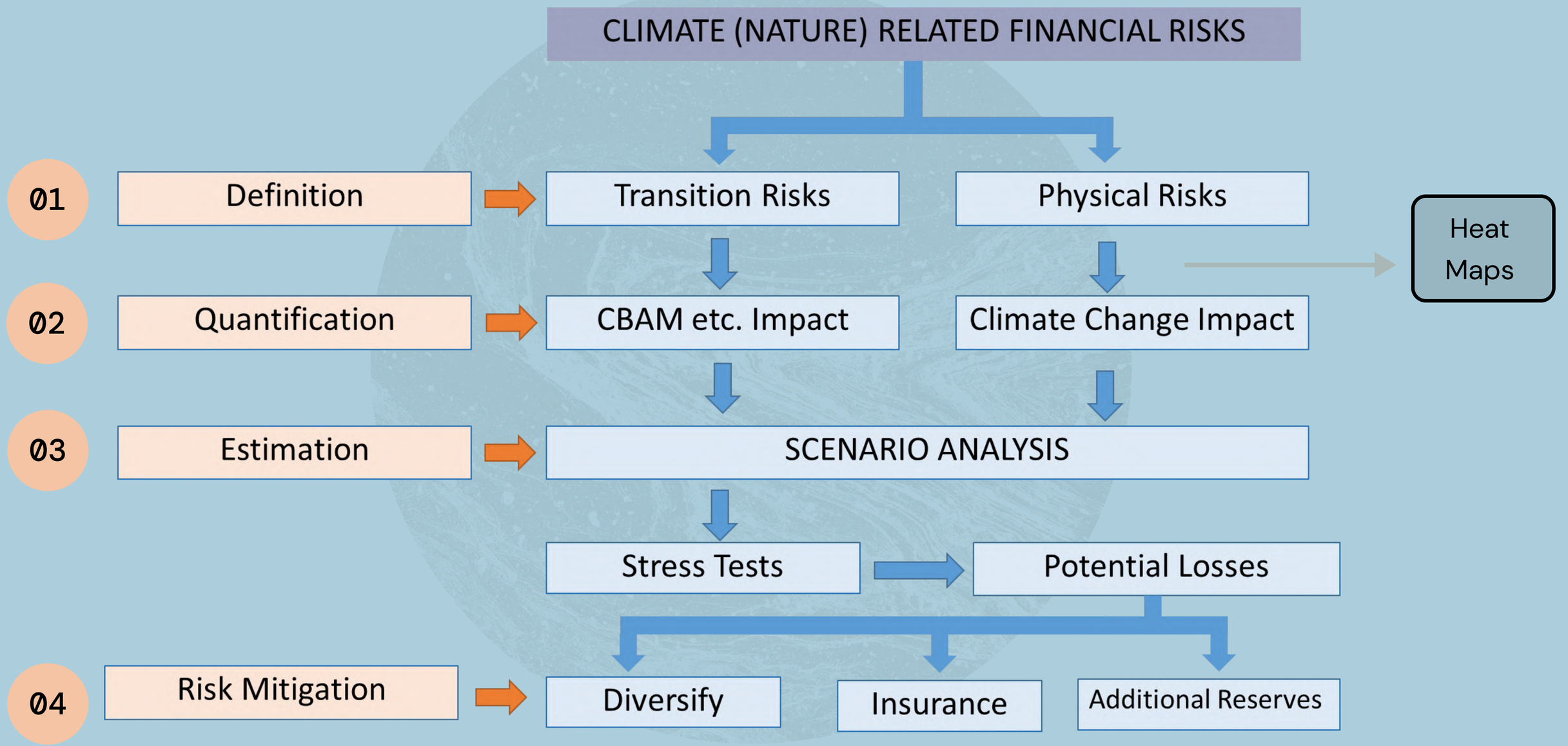
- develop an analytical framework to analyse the interactions between nature and financial system,
- bridge data gap that emerges from their analytical framework and
- use the framework to assess nature-related financial risks and set policies about environmental sustainability*.

(2) Supervisory authorities may (or should) use reasonable assumptions and proxies to solve data gap problems**.

** https://www.ngfs.net/sites/default/files/medias/documents/statement_on_nature_related_financial_risks_-_final.pdf*

*** https://www.bis.org/bcbs/publ/d530.pdf (Basel Committee on Banking Supervision "Principles for the effective management and supervision of climate-related financial risks")*

FRAMEWORK (Draft)



Definitions

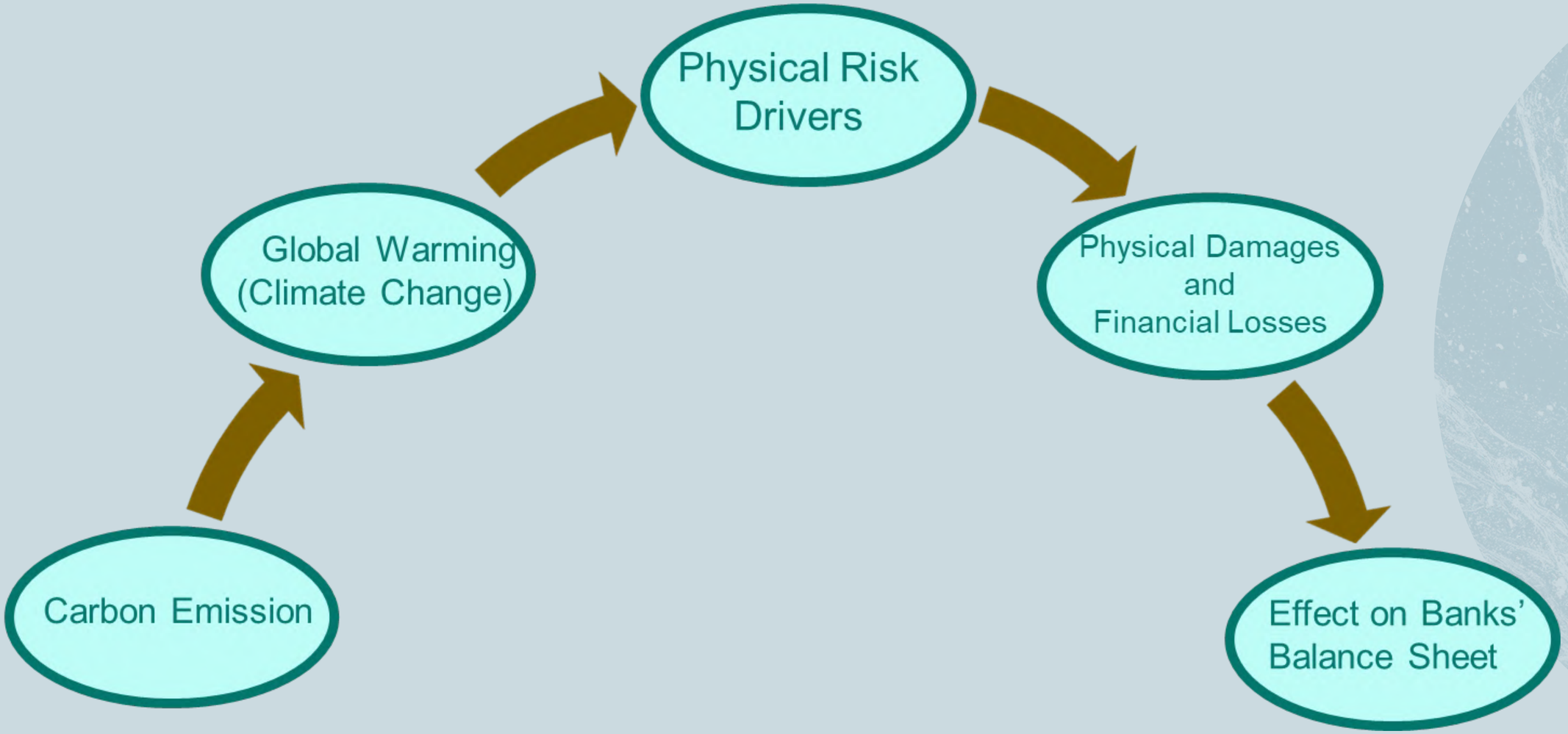
Physical Risks: Economic costs or financial losses due to climate change and the resulting extreme natural events (acute risks, chronic risks and indirect effects).

Physical Risk Drivers: Climate change events such as floods and hail storms that lead to physical risks and financial losses on the general economy and financial sector.

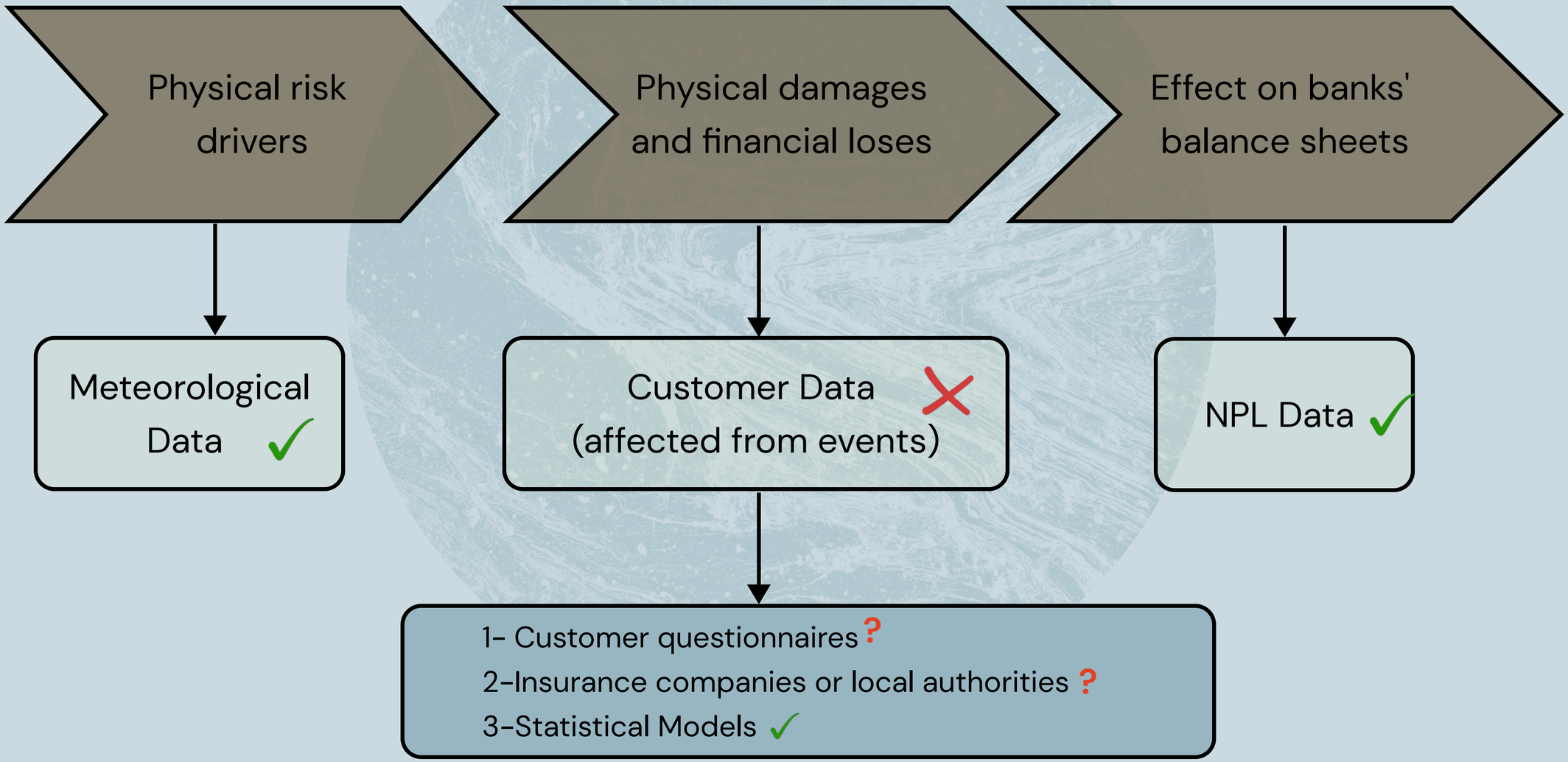
Transmission Channel: The process by which physical and transit risks affect banks directly or indirectly through the activities of exposed parties.

https://www.bis.org/bcbs/publ/d530.pdf (Basel Committee on Banking Supervision “Principles for the effective management and supervision of climate-related financial risks")

Physical Risk Transmission Channel



Physical Risk Data



Literature Review

Year	Authors	Title	Model	Result
2021	Wan-Li Zhang, Chun-Ping Chang, Yang Xuan	The impacts of climate change on bank performance: What is the mediating role of natural disasters?	Panel Data Analyses	A significant relationship was found between the decrease in forestlands and the increase in carbon dioxide emissions and the increase in the non-performing loan ratio of banks.
2021	Kellie Bellrose, David Norman, Michelle Royters	Climate Change Risks to Australian Banks	Scenario Analysis	It has been determined that the price decreases in housing prices in regions exposed to extreme weather conditions cause credit losses
2021	Sante Carbone, Margherita Giuzio, Sujit Kapadia, Johannes Sebastian Krämer, Ken Nyholm, Katia Vozian	The low-carbon transition, climate commitments and firm credit risk	Regression and Difference in Differences Analysis.	It has been determined that higher greenhouse gas emissions and emission intensities measures are associated with higher credit risk, and governments' climate policies and expectations regarding these policies affect companies' transition risk and therefore credit risk.
2021	Siamak Javadia, Abdullah-Al Masumb	The impact of climate change on the cost of bank loans	Panel Data Analysis.	There is solid empirical evidence that companies in locations more exposed to climate change pay significantly higher margins on bank loans.
2021	Blair Bateson, Dan Saccardi	Financing a Net Zero Economy: The Consequences of Physical Climate Risk for Banks	CLIMAFIN Methodology and Scenario Analysis.	It has been determined that the annual value-at-risk arising from the effects of physical climate change in syndicated loan portfolios of large US banks may approach 10% even if adaptation measures are taken.
2021	Jagdeep Kaur Brar, Antoine Kornprobst, Willard John Braun, Matthew Davison, Warren Hare	A Case Study of the Impact of Climate Change on Agricultural Loan Credit Risk	Case Analysis, Scenario Analysis, Simulation Method	It has been revealed that agricultural loans are directly affected by climate change and that agricultural loan application approvals can be given with the simulation of which agricultural product can be produced depending on temperature and adhesion changes in the agricultural area subject to the loan.
2021	Roland Walles, Rutger Jansen, Marco Folpmers	Climate change related credit risk Case study for U.S. mortgage loans	Case study. Scenario Analysis. Logit Model.	It has found that risks related to climate change can be modelled for a particular portfolio and that climate risk modelling methodologies need to be developed.
2020	Oluwaseun James Oguntuase	Climate Change, Credit Risk and Financial Stability	Scenario Analysis.	It has been found that climate change causes credit risk and financial instability, and therefore there is a need for a roadmap that includes the necessary strategies and approaches to manage the risks related to climate change.
2020	Albert Henry Ntarmah, Yusheng Kong, Eric Cobbinah, Michael Kobina Gyan, Emmanuel Kwaku Manu	Analysis of the Responsiveness of Environmental Sustainability to Non-Performing Loans in Africa	GMM, Panel VAR, Quantitative Regression.	Environmental conditioning on other sustainability determinants other than climate change has been found to have a negative impact on NPLs.

METHODOLOGY

Vector Autoregressive Model (VAR)

- VAR is a statistical model used to capture the relationship between multiple quantities as they change over time.

- VAR is a multivariate time series model that relates current observations of a variable with past observations of itself and past observations of other variables in the system.

- Spesification of VAR Model:

  Y and X two different variable and X, Y ~ I (0);

$$Y_t = \alpha_{11} + \beta_{11}Y_{t-1} + \beta_{12}Y_{t-2} + \gamma_{11}Y_{t-1} + \gamma_{12}Y_{t-2} + u_{11t}$$

$$X_t = \alpha_{21} + \beta_{21}X_{t-1} + \beta_{22}X_{t-2} + \gamma_{21}X_{t-1} + \gamma_{22}X_{t-2} + u_{21t}$$

DATA

1- Physical Risk Drivers (Climate data)

- Antalya Province, June 2010- December 2019 periods, deviation of "average temperature", "maximum temperature" and " precipitation"; "extreme weather events".

2- NPL Data

- Antalya Province, banking sector, June 2010- December 2019 periods, agriculture, energy and paper, food and timber manufacturing, NPL "flow" data (with 3 months lag).

Antalya ?

- Mediterrenian Region
- Agriculture
- Tourism
- Energy
- Manufacturing

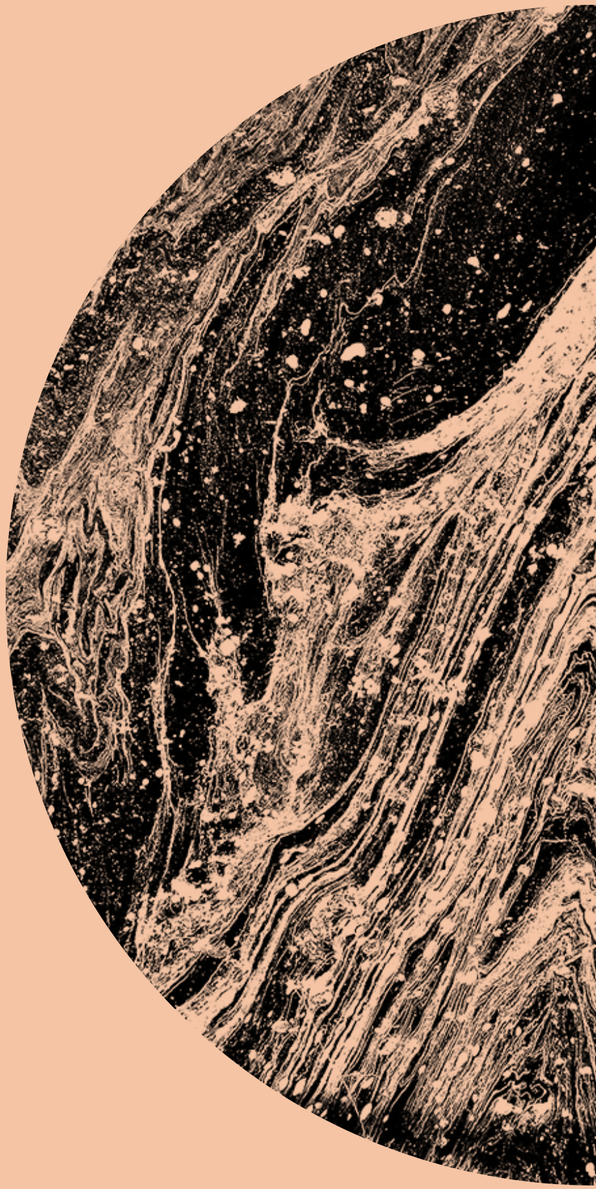
Antalya;

- ranks 6th in terms of contribution to GDP,
- ranks 4th in terms of total loans and
- ranks 5th in terms of population.

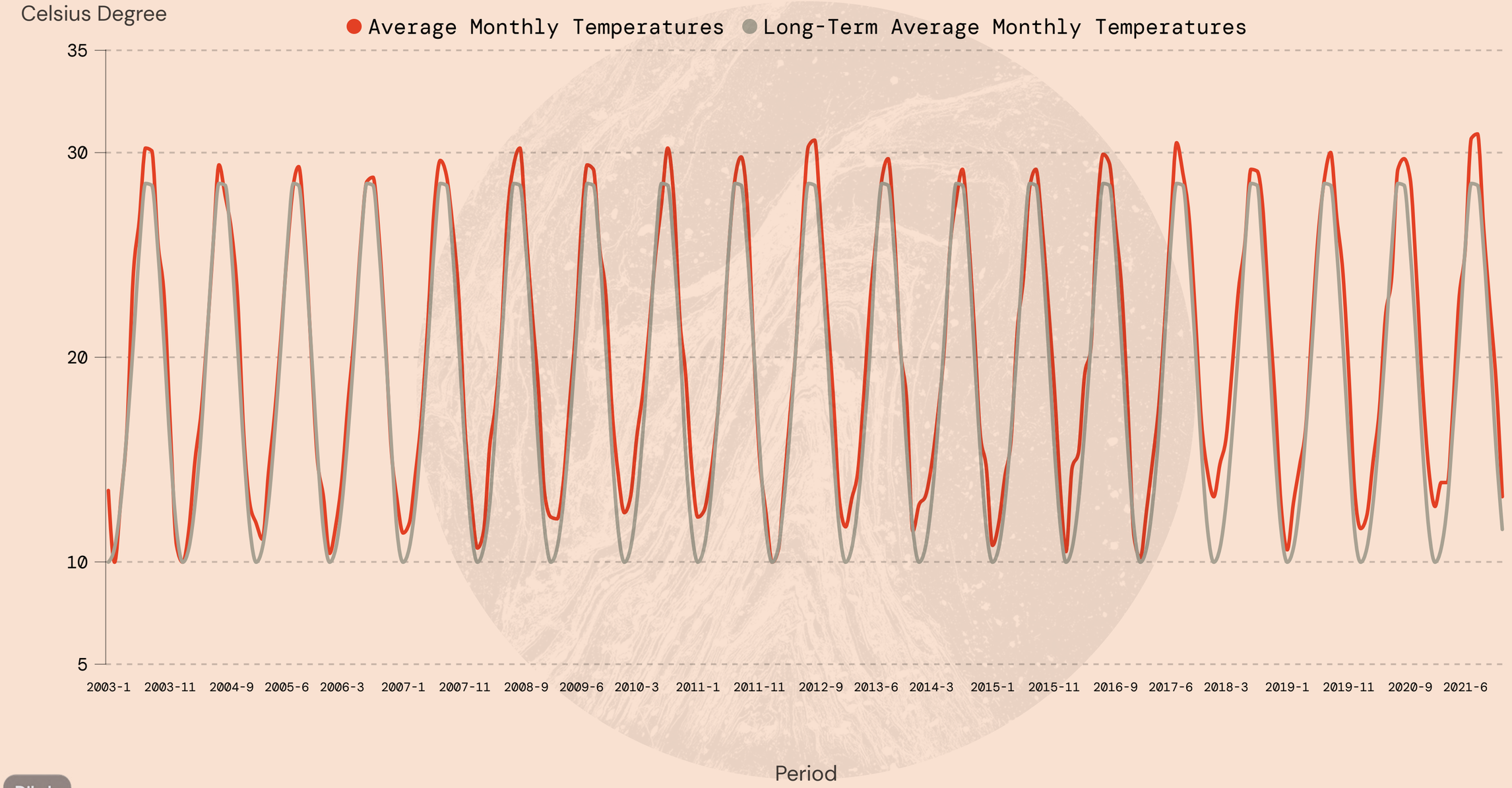
02

Climate Change

Physical Risk Drivers

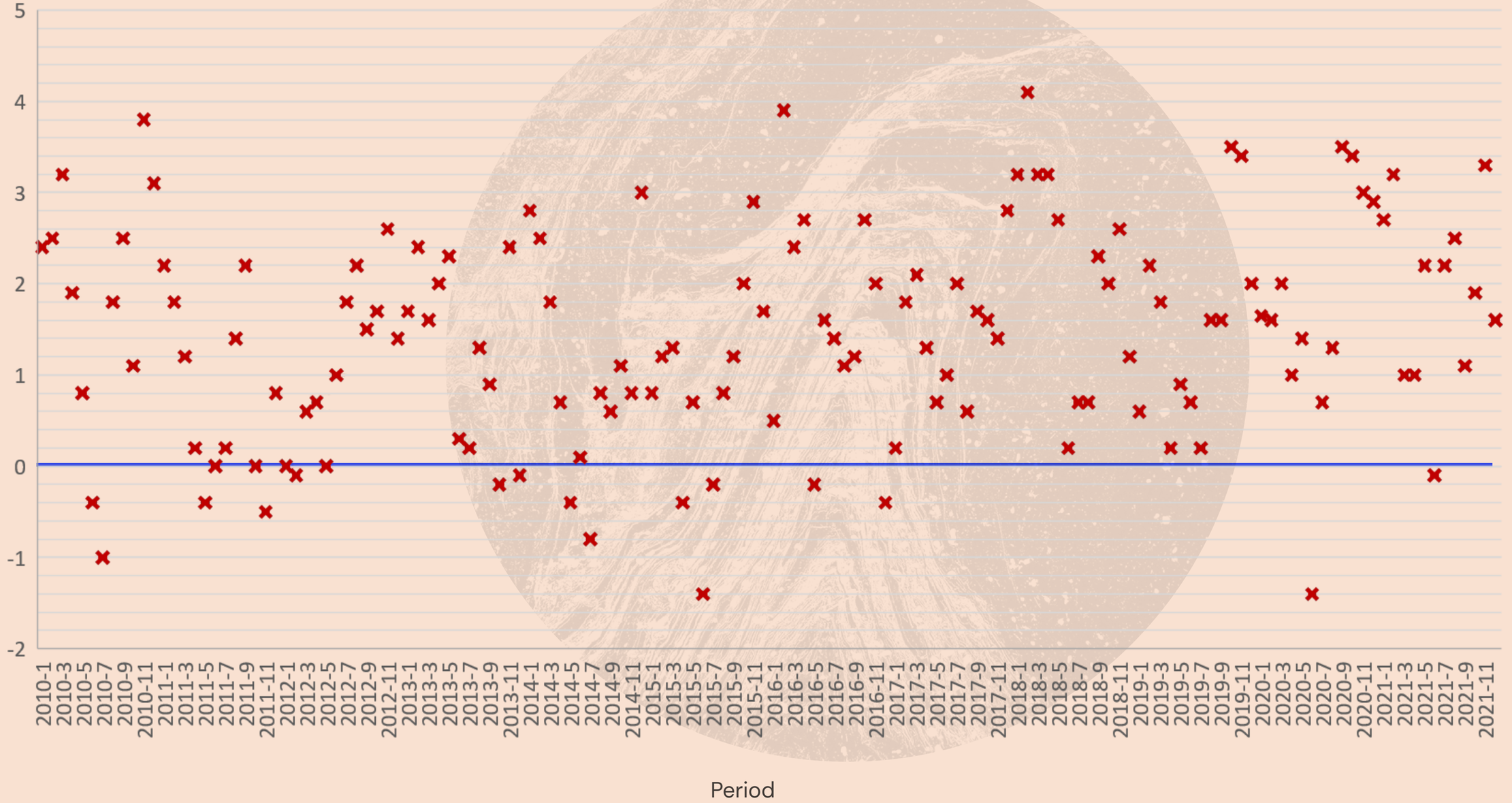


Antalya Province - Deviation of Average Temperatures

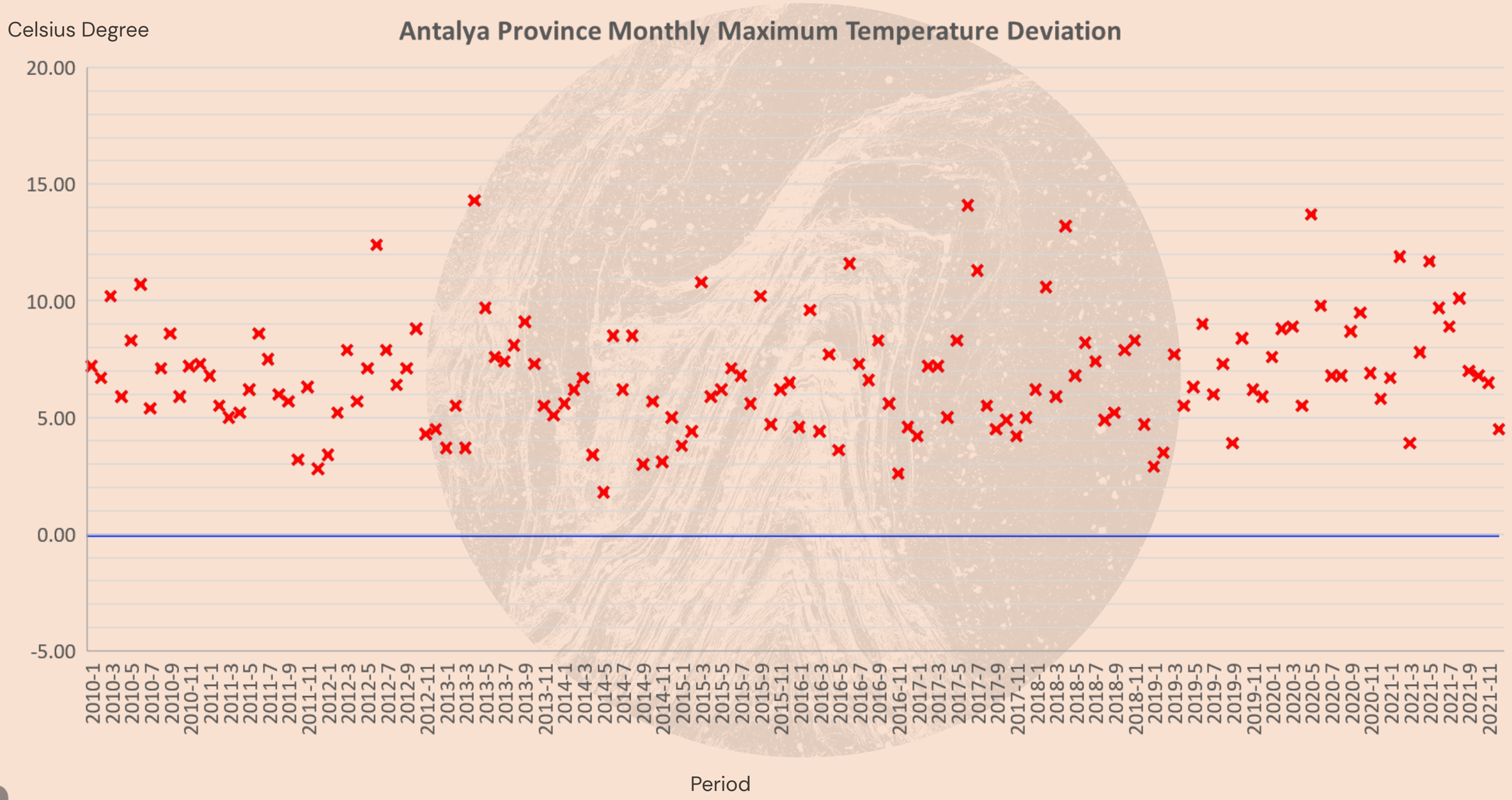


Celsius Degree

Antalya Province - Deviation of Average Temperature



Period


Celsius Degree
Antalya Province Monthly Maximum Temperature Deviation
20.00
15.00
10.00
5.00
0.00
-5.00
2010-1
2010-3
2010-5
2010-7
2010-9
2010-11
2011-1
2011-3
2011-5
2011-7
2011-9
2011-11
2012-1
2012-3
2012-5
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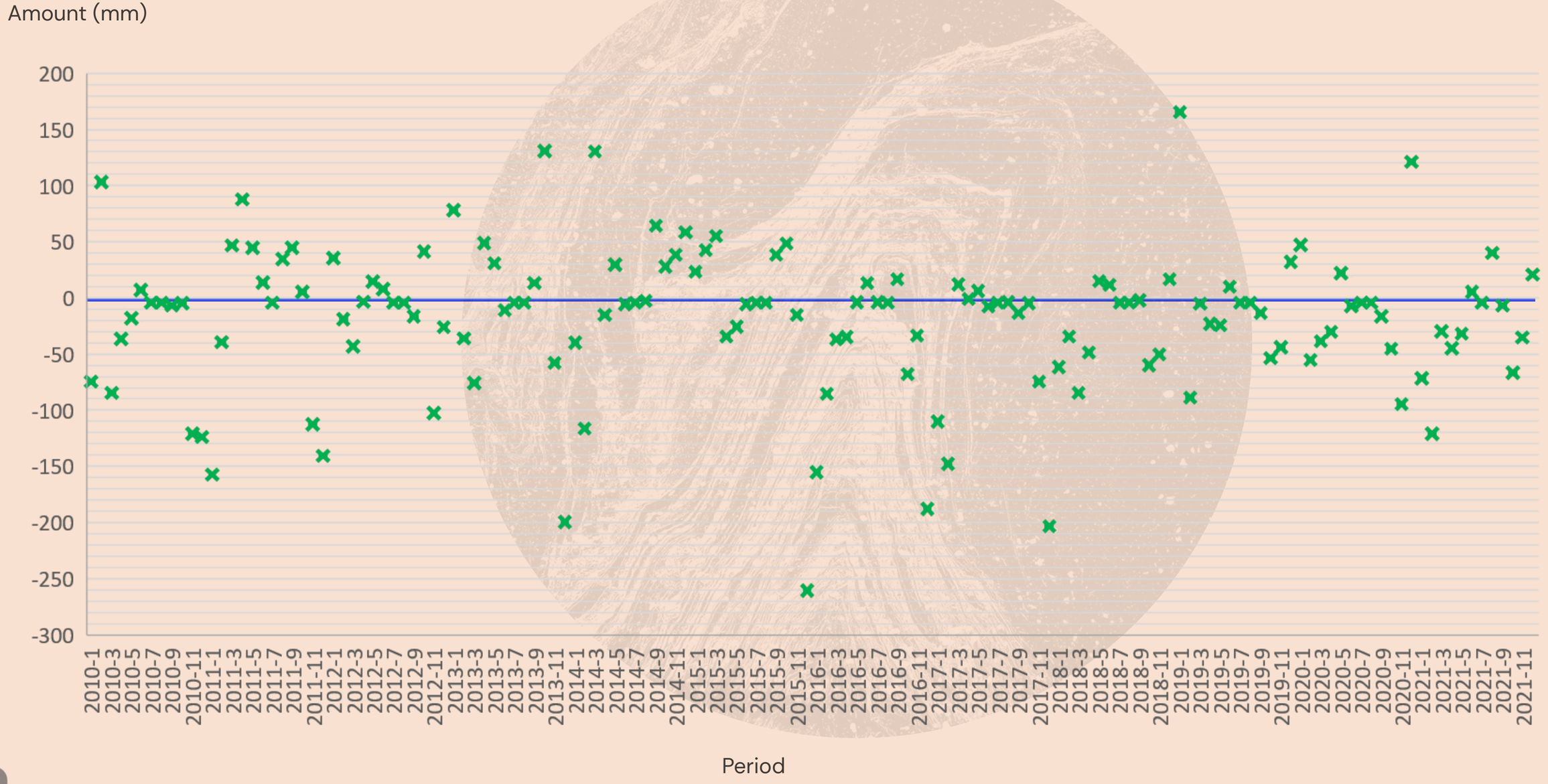
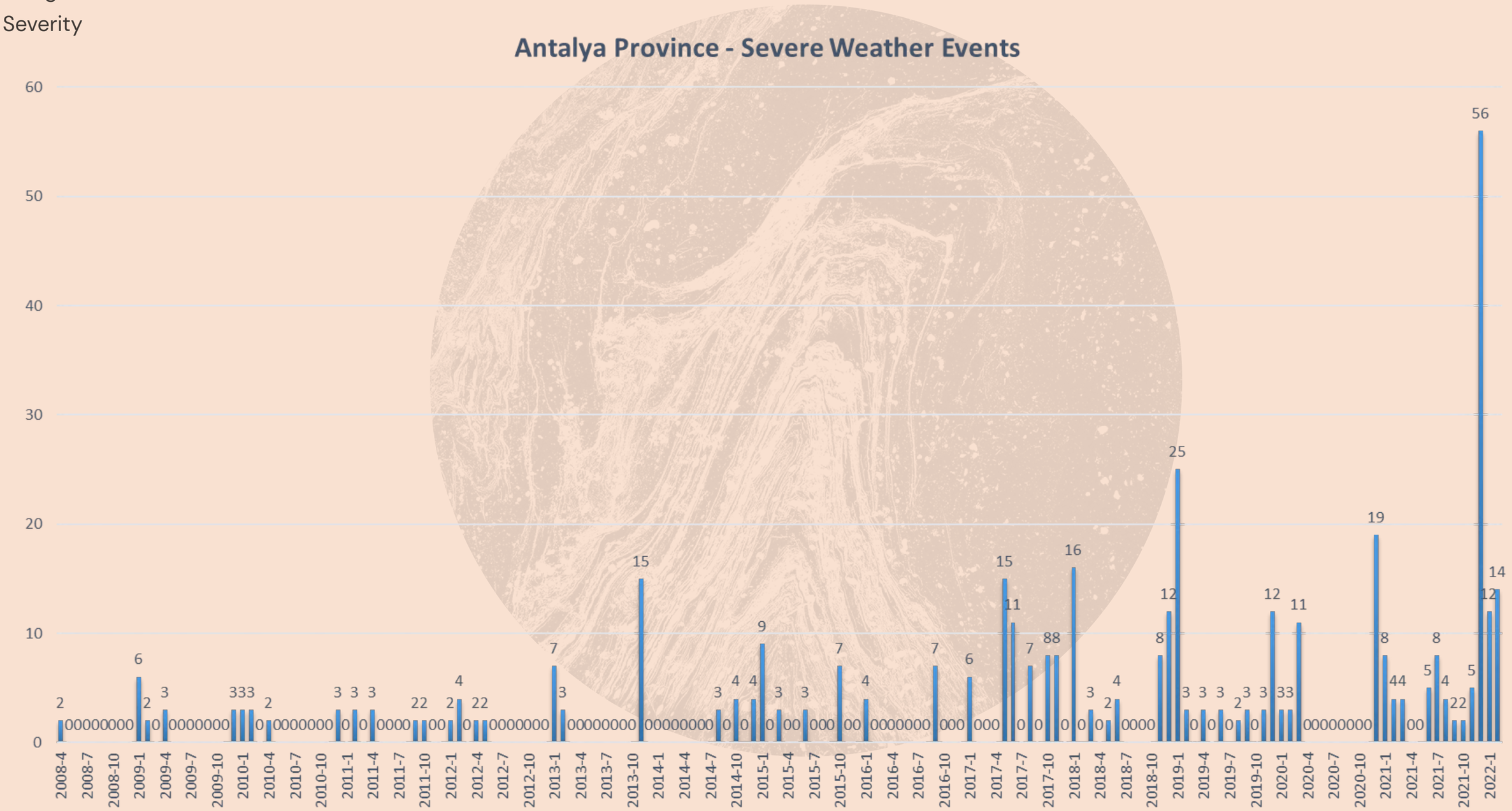
2020-9
2020-11
2021-1
2021-3
2021-5
2021-7
2021-9
2021-11
Period

Antalya Province – Deviation of Precipitation Amount



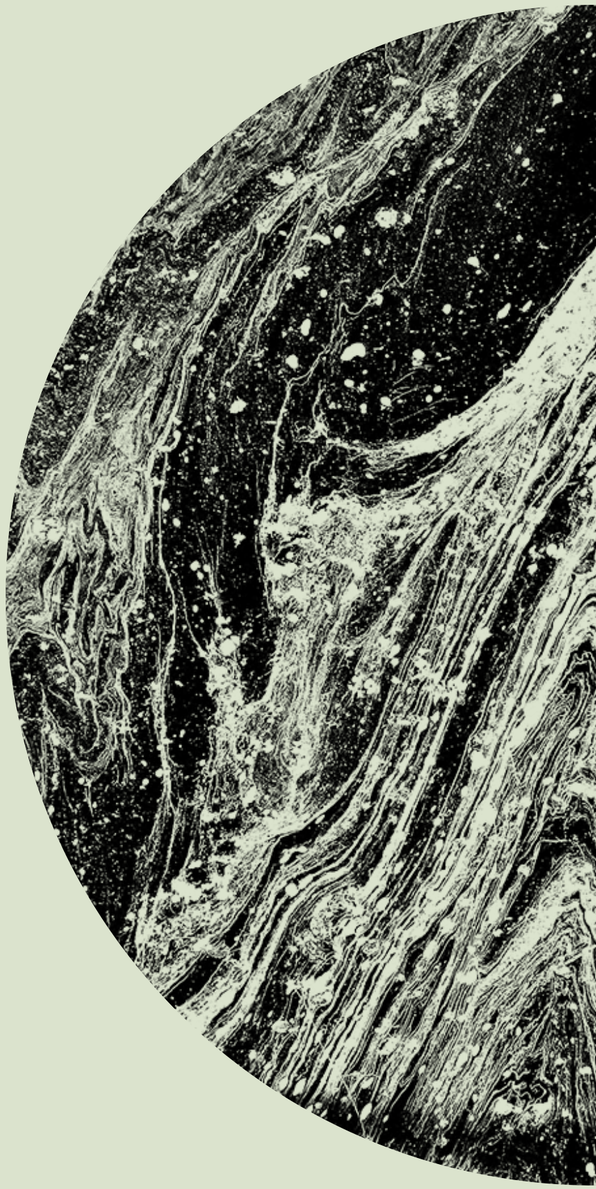
Total Degree of Severity



Time and date	Event Definition	Damage Definition	Precipitation Amount	Wind Speed	Impact Severity
804281815	24- Hail	16- Fruit trees were damaged.	27	0	02- Modarate
901269999	18- Storm	56- Other	0	0	01- Mild
901259999	73- Cyclone	56- Other	0	0	01- Mild
901290050	19- Storm	56- Other	0	28.1	02- Modarate
902140700	44- Strong Rain Shower	44- People, animals, transportation vehicles and residential areas were damaged.	170.8	20.6	02- Modarate
904150005	24- Heavy Hail	33- Crops grown under the cover were damaged.	8888	8888	03- Severe
912170050	48- Overflow in rivers due to heavy rainfall.	42- Transportation vehicles were damaged.	111.7	25.8	03- Severe
912290300	44- Flood in residential areas due to heavy rainfall.	34- Residential areas were damaged.	139.1	0	03-Severe
1002081830	44- Flood in residential areas due to heavy rainfall.	44- People, animals, transportation vehicles and residential areas were damaged.	136.8	25.7	04- Very Severe

03

Physical Risk Analysis

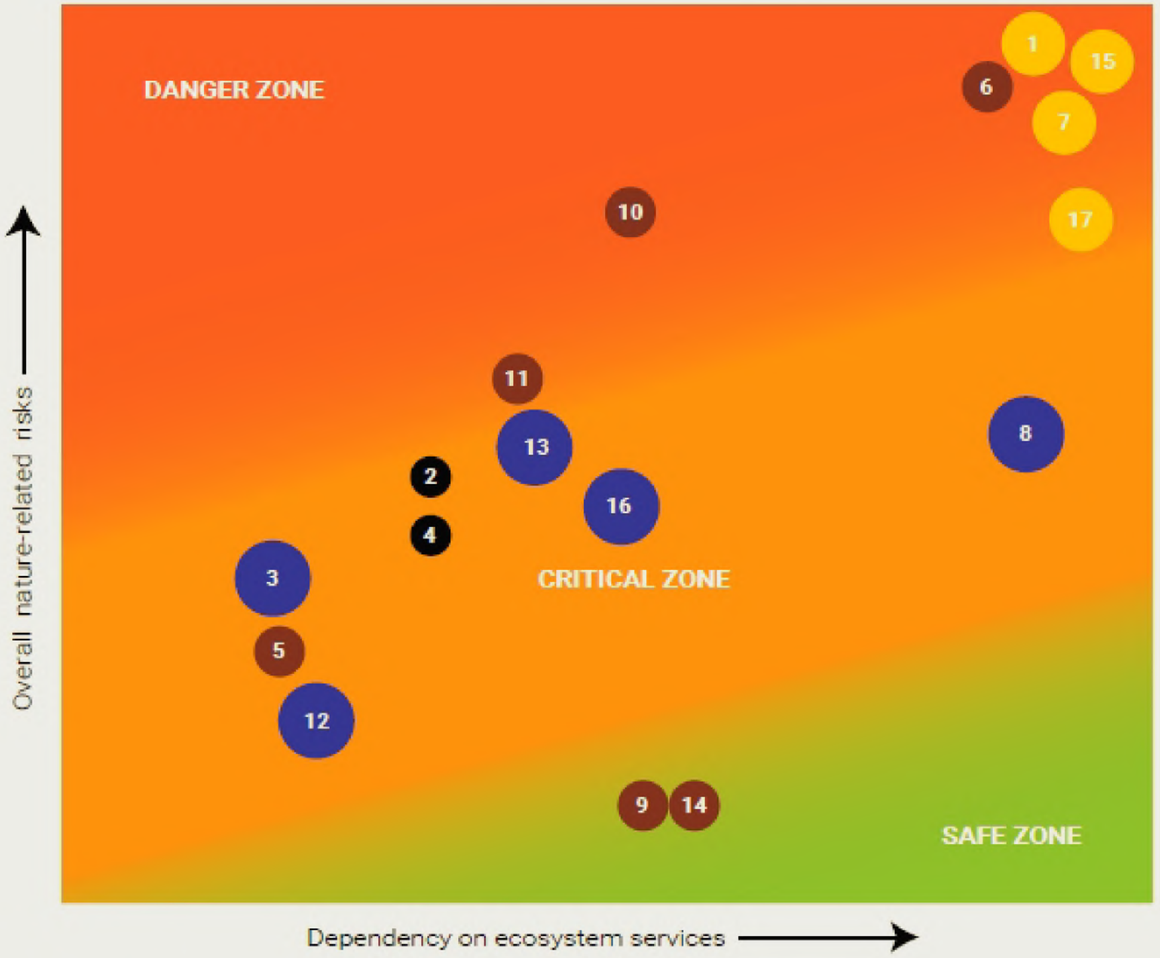


Assumptions

- The main transmission channel for physical risks is financial losses due to physical damages.
- For banks the most important risk, related to physical risks, is the credit risk
- Agriculture, tourism, energy and food, paper and timber manufacturing sectors are the most exposed sectors to physical risks.*

*https://www.sustainableinsuranceforum.org/view_pdf.php?pdf_file=wp-content/uploads/2021/11/UN_Nature-Related-Risks-in-the-Global-Insurance-Sector_v9.pdf

Figure 10 **Directional estimate of overall nature-related risks for economic sectors**[19]



Sectors

1. Agriculture, Fishery & Livestock
2. Apparel & Textiles
3. Automotive
4. Chemical
5. Construction & Engineering
6. Food & Beverage
7. Manufacturing (paper, pulp, timber)
8. Manufacturing (others; e.g. metals)
9. Media & Entertainment
10. Mining & Quarrying
11. Oil & Gas
12. Pharmaceutical, Healthcare, Life Sciences & Biotech
13. Real Estate
14. Telecommunications & IT
15. Tourism, Travel & Hospitality
16. Transportation & Storage
17. Utilities (electricity, energy, water)

Global Property & Casualty Insurance Premium (2019)

- > US$50 billion
- US$30–50 billion
- US$10–30 billion
- < US$10 billion

Danger Zone: Where business operation will potentially be highly disrupted

Critical Zone: Where business operation will potentially be moderately disrupted

Safe Zone: Where business operation will likely continue as business-as-usual

Source: Author's estimations and calculations based on McKinsey & Company's Global Insurance Pools database, publicly available insurance premium data from various market research firms and consultation with insurance industry experts

Model

$$NPL_{i,t} = \alpha_{10} + \alpha_{11}NPL_{i,(t-1)} + \alpha_{12}NPL_{i,(t-2)} + \cdots + \alpha_{1n}NPL_{i(t-n)} + \beta_{11}PRD_{i,(t-1)} + \beta_{12}PRD_{i,(t-2)} + \cdots + \beta_{1n}PRD_{i(t-n)} + \varepsilon_t$$

$$PRD_{i,t} = \alpha_{10} + \alpha_{11}PRD_{i,(t-1)} + \alpha_{12}PRD_{i,(t-2)} + \cdots + \alpha_{1n}PRD_{i(t-n)} + \beta_{11}NPL_{i,(t-1)} + \beta_{12}NPL_{i,(t-2)} + \cdots + \beta_{1n}NPL_{i(t-n)} + u_t$$

$NPL_i = NPL_{AG} =$ Amount of Agricultural NPL (flow)

$= NPL_{TR} =$ Amount of Tourism NPL (flow)

$= NPL_{EN} =$ Amount of Energy NPL (flow)

$= NPL_{PP} =$ Amount of Paper Manufacturing NPL (flow)

$= NPL_{FO} =$ Amount of Food Manufacturing NPL (flow)

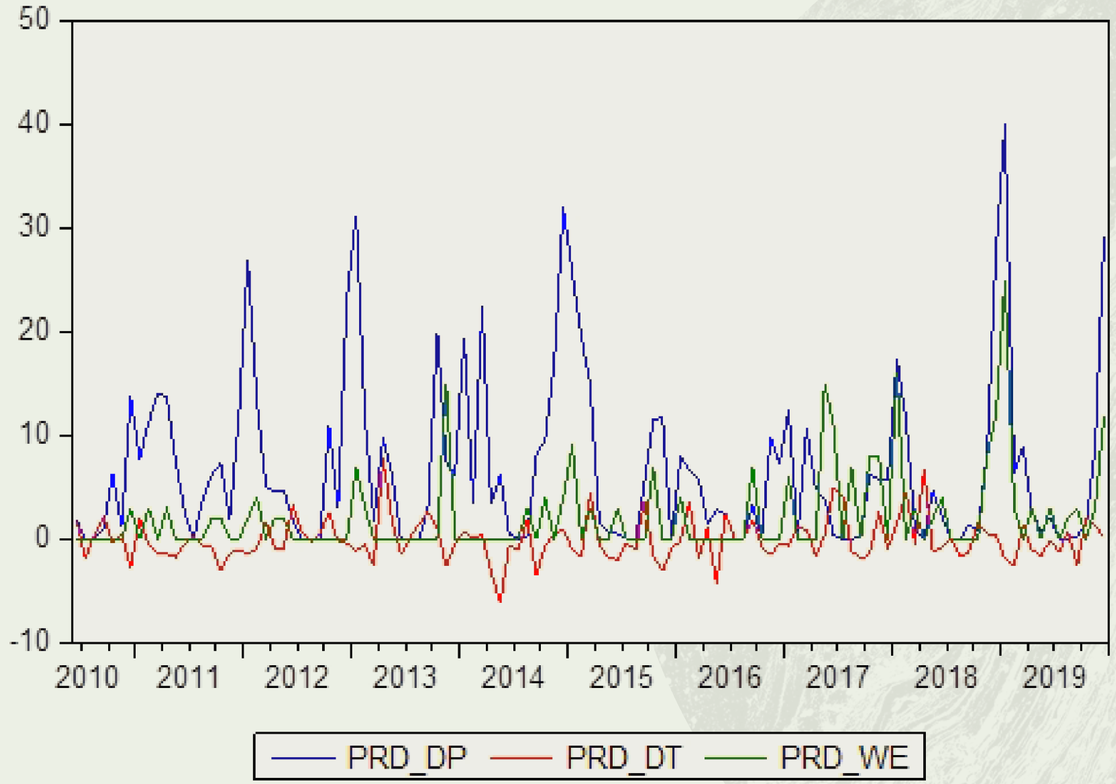
$= NPL_{TB} =$ Amount of Timber Manufacturing NPL (flow)

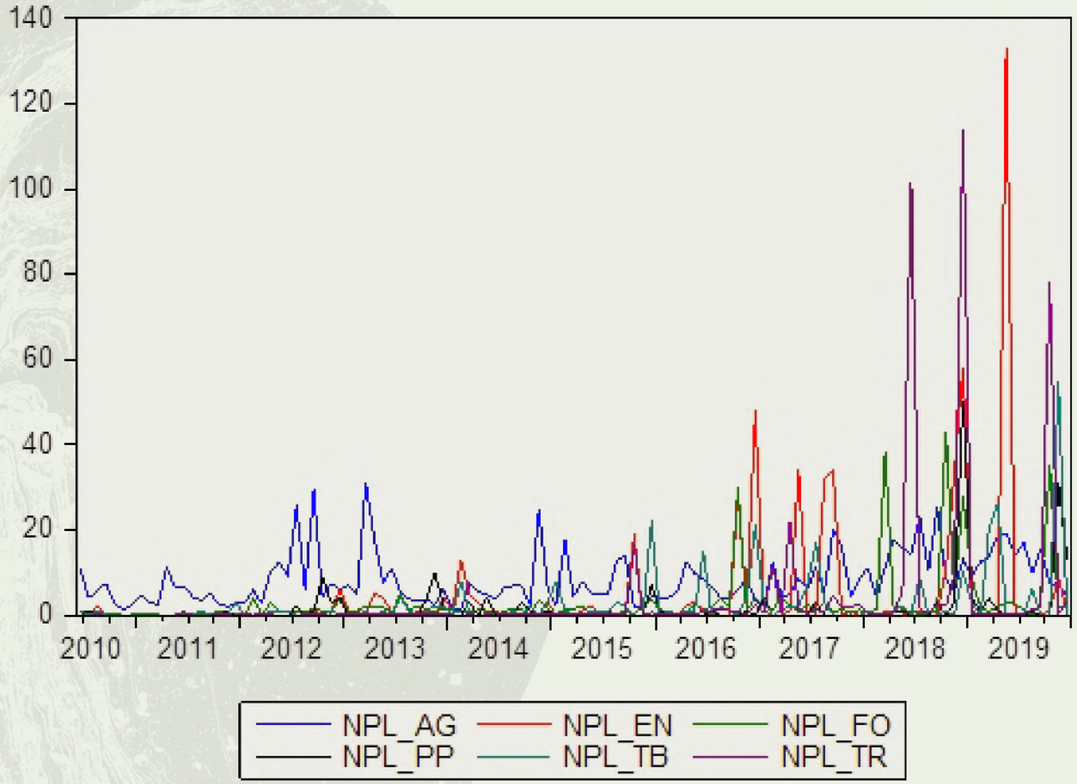
$PRD_i = PRD_{WE} =$ Physical Risk Drives (Severe Weather Events)

$= PRD_{DP} =$ Physical Risk Drives (Deviation of Precipitation)

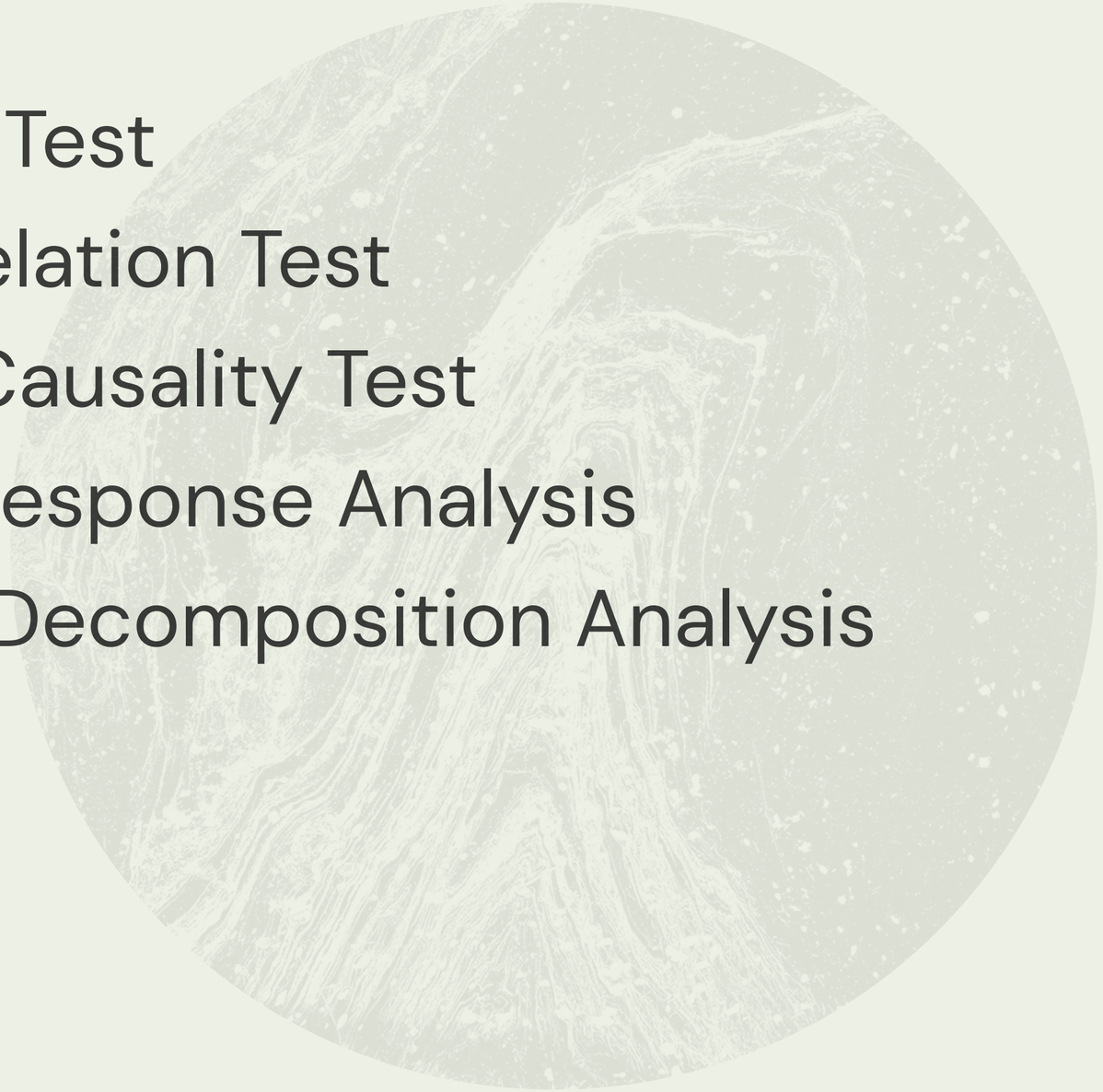
$= PRD_{DT} =$ Physical Risk Drives (Deviation of Temperature)

Time Series





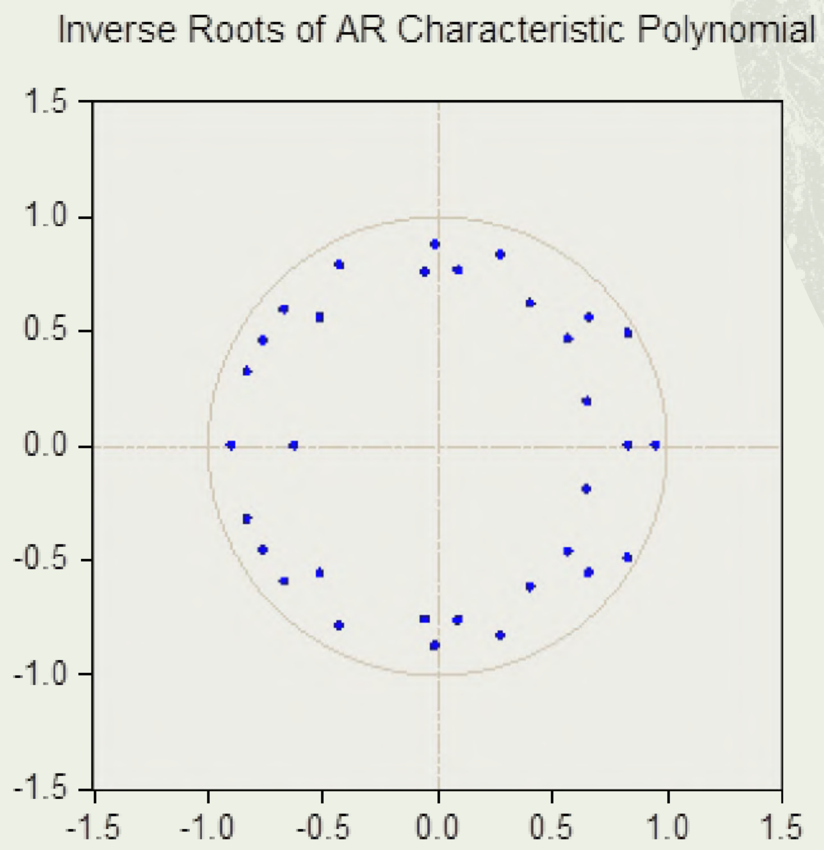
VAR Analysis Steps

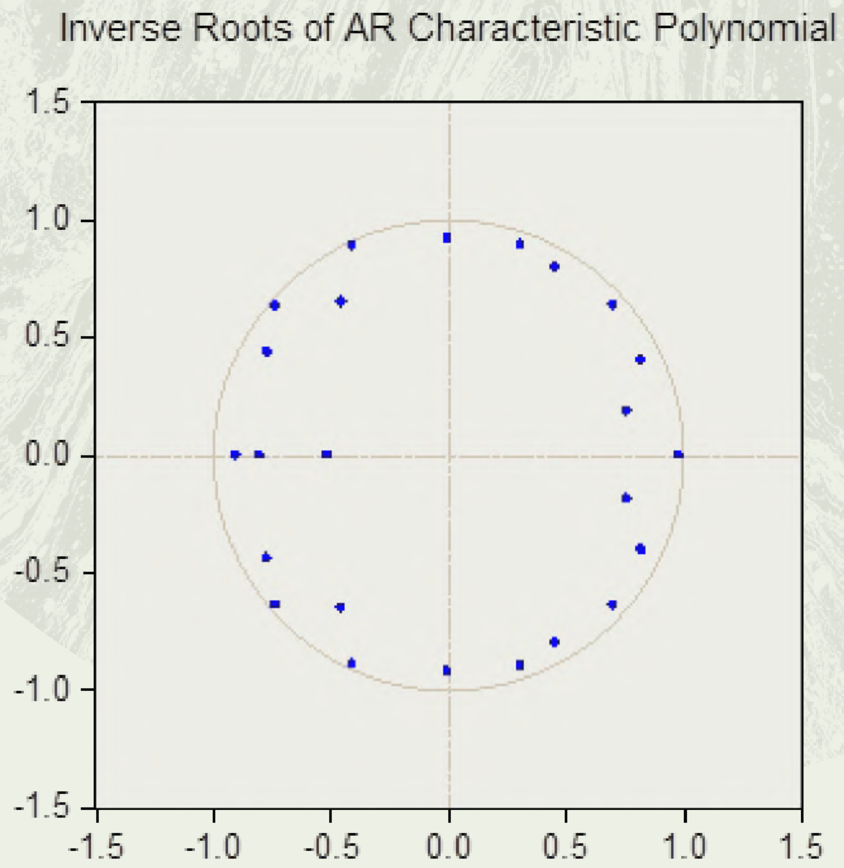


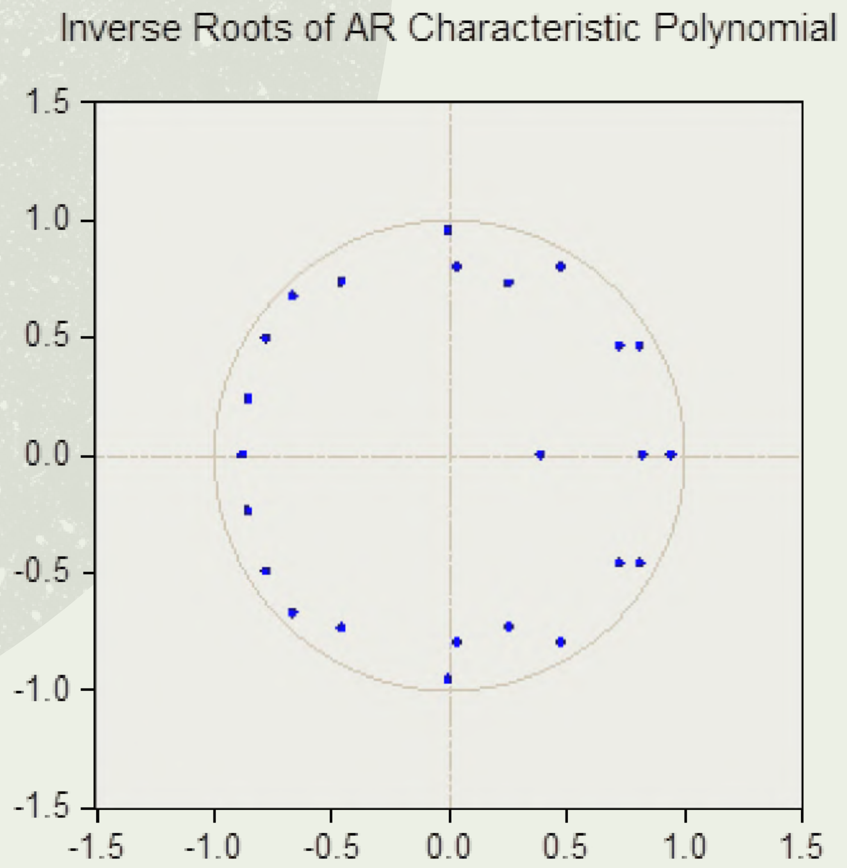
- Unit Root Test
- Autocorrelation Test
- Granger Causality Test
- Impulse Response Analysis
- Variance Decomposition Analysis

Unit Root Test

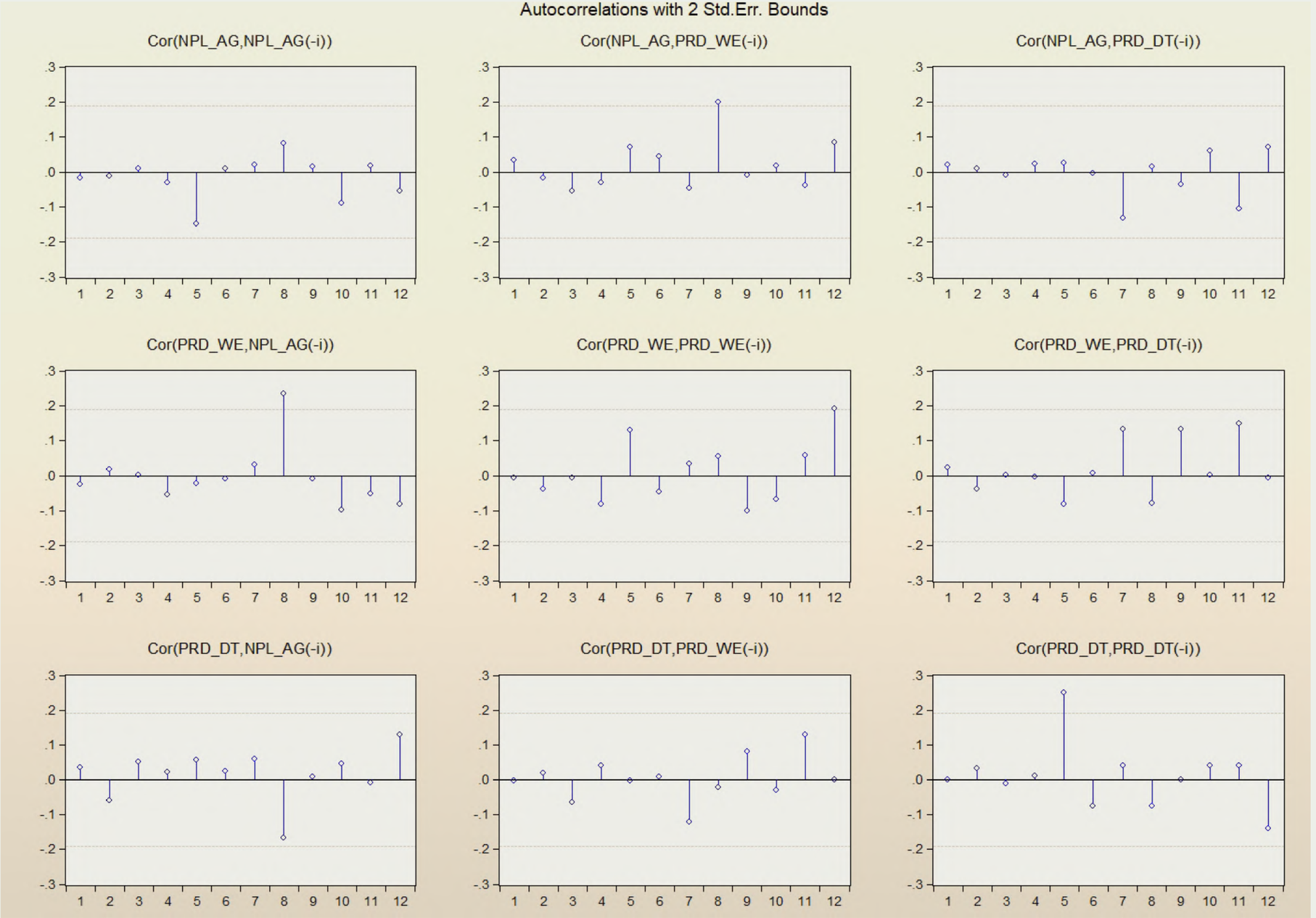
Variable	Augmented Dickey-Fuller		Phillips-Perron	
	T-statistic	Prob.	T-statistic	Prob.
NPL_{AG}	-4.833795	0.0001	-8.910349	0.0000
NPL_{TR}	-10.37457	0.0000	-10.37336	0.0000
NPL_{EN}	-9.987362	0.0000	-9.972256	0.0000
NPL_{FO}	-10.19671	0.0000	-10.23251	0.0000
NPL_{PP}	-8.766660	0.0000	-8.766660	0.0000
NPL_{TM}	-10.13861	0.0000	-10.13912	0.0000
PRD_{WE}	-8.668982	0.0000	-8.690658	0.0000
PRD_{DP}	-5.912059	0.0000	-5.726078	0.0000
PRD_{DT}	-10.75870	0.0000	-10.77972	0.0000







Autocorrelation (LM Test)

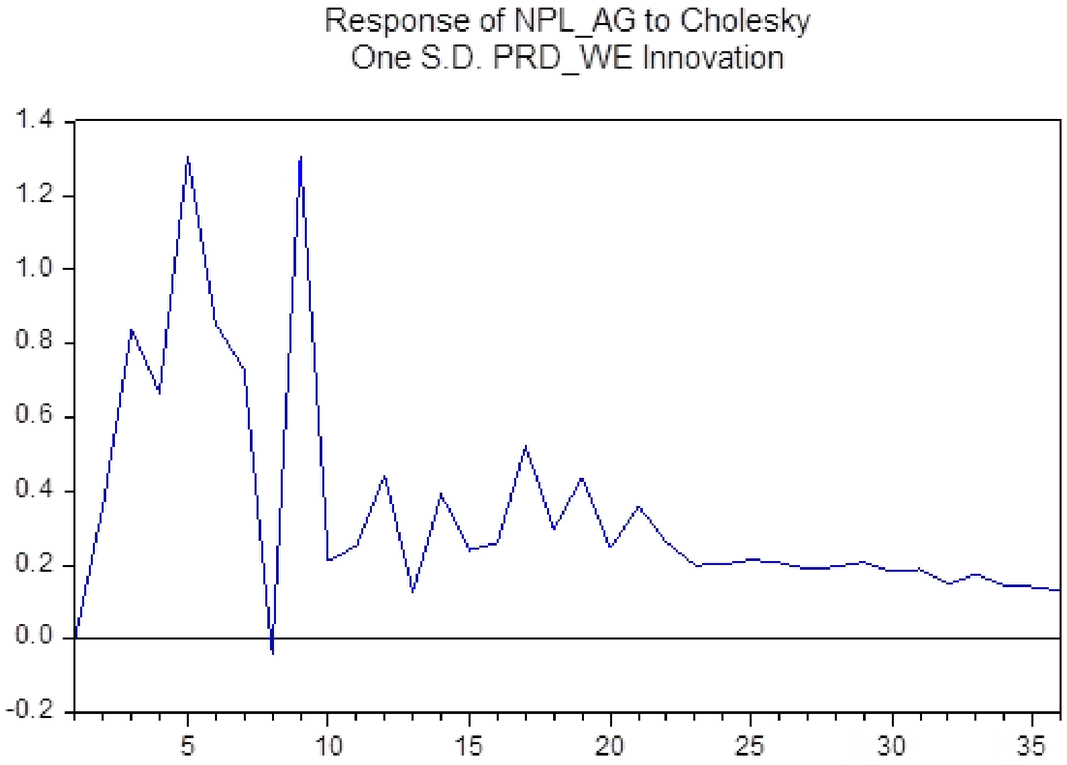


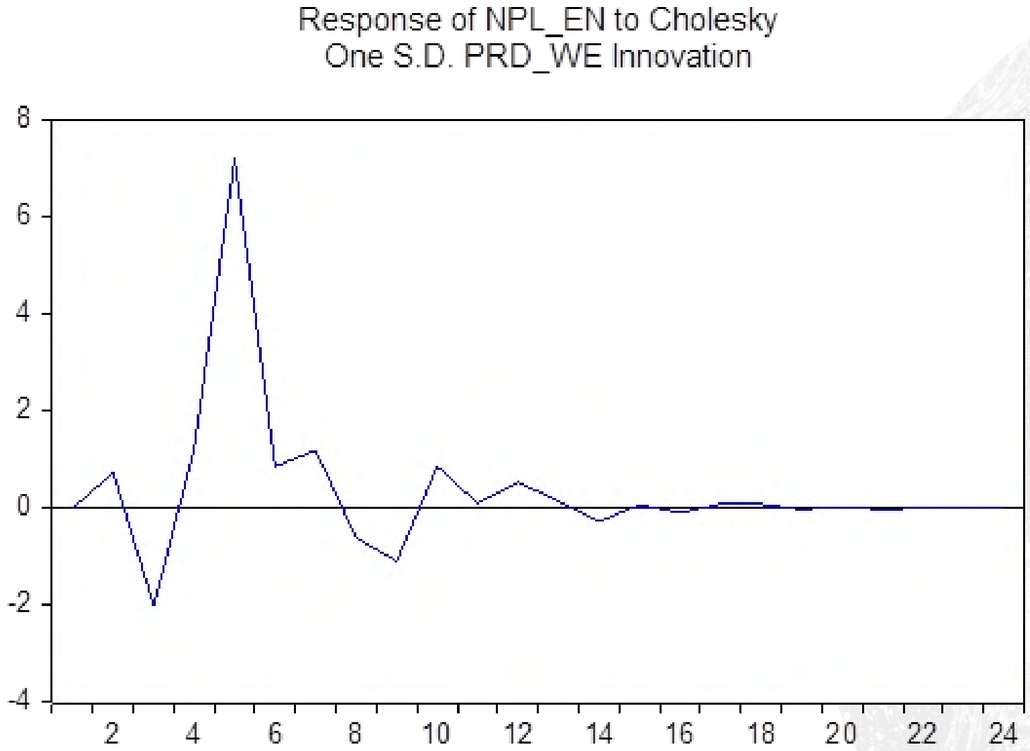
Granger Causality

GRANGER CAUSALITY TESTS			
Independent Variables / Dependent Variables	PRD_{WE}	PRD_{DP}	PRD_{DT}
NPL_{AG}	0.0998	0.0063	0.0032
NPL_{TR}	0.7390	0.4399	0.1271
NPL_{EN}	0.0032	0.2272	0.5049
NPL_{FO}	0.3994	0.3604	0.0637
NPL_{PP}	0.4353	0.4745	0.3362
NPL_{TM}	0.0232	0.7763	0.1886

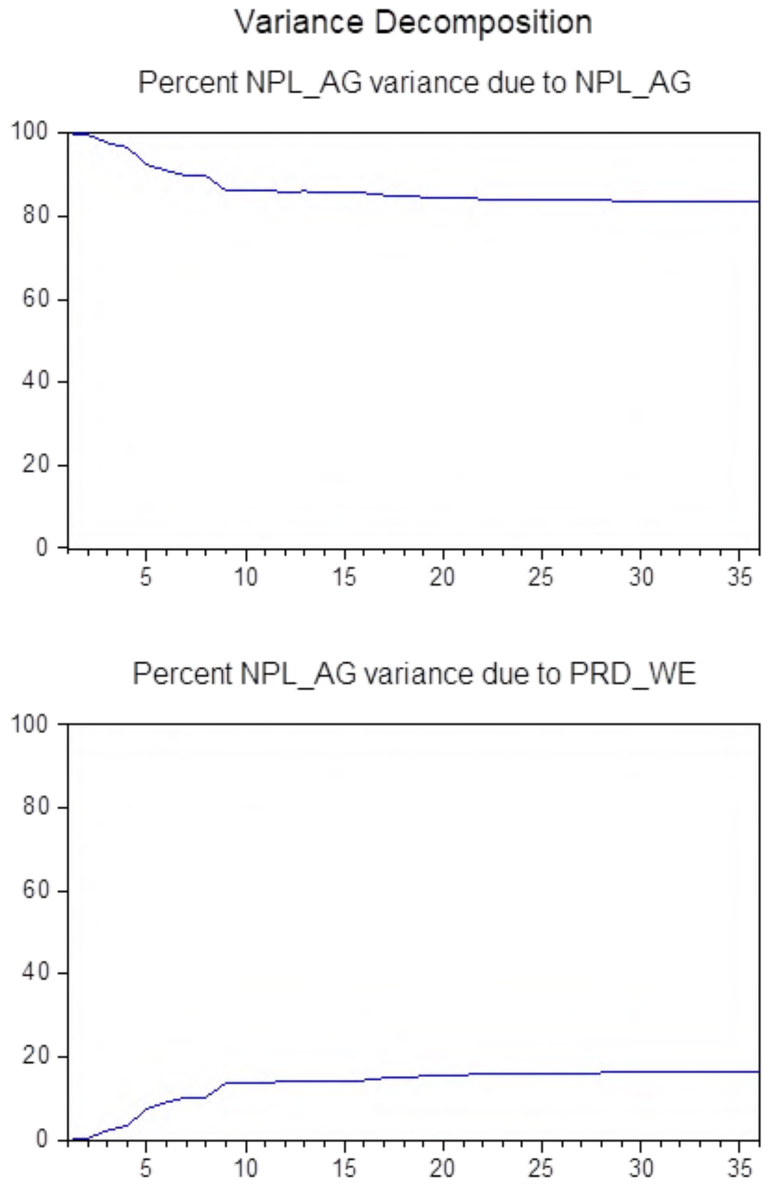
	Significant
	Insignificant

Impulse Response Analysis





Variance Decomposition Analysis



Period	S.E.	NPL_AG	PRD_WE
1	5.793089	100.0000	0.000000
2	5.807052	99.60761	0.392395
3	6.003029	97.68549	2.314506
4	6.128315	96.59515	3.404854
5	6.284757	92.43806	7.561939
6	6.385441	90.89270	9.107296
7	6.429078	89.73452	10.26548
8	6.429518	89.73135	10.26865
9	6.565199	86.20462	13.79538
10	6.582262	86.17182	13.82818
11	6.619930	86.18375	13.81625
12	6.647556	85.85260	14.14740
13	6.703923	86.05407	13.94593
14	6.717944	85.77358	14.22642
15	6.731475	85.70269	14.29731
16	6.737929	85.58106	14.41894
17	6.764669	85.09889	14.90111
18	6.772141	84.93920	15.06080
19	6.787496	84.59075	15.40925
20	6.796335	84.50063	15.49937
21	6.808052	84.27492	15.72508
22	6.814955	84.16011	15.83989
23	6.821215	84.10338	15.89662
24	6.825725	84.03773	15.96227
25	6.833720	83.97554	16.02446
26	6.838397	83.90665	16.09335
27	6.843799	83.85475	16.14525
28	6.848198	83.79476	16.20524
29	6.853312	83.72636	16.27364
30	6.856834	83.67264	16.32736
31	6.860280	83.61360	16.38640
32	6.862828	83.57836	16.42164
33	6.865958	83.52803	16.47197
34	6.868213	83.49460	16.50540
35	6.870508	83.46360	16.53640
36	6.872520	83.43660	16.56340

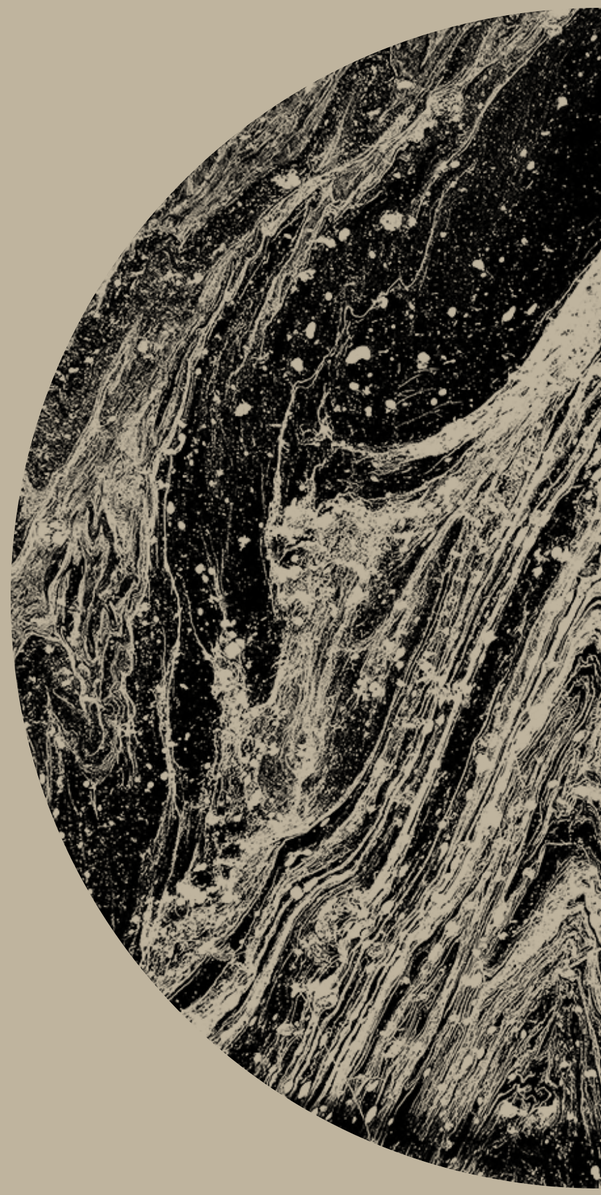
Cholesky Ordering: NPL_AG PRD_WE

Variance Decomposition Analysis

Independent Variables / Dependent Variables	PRD_{WE}	PRD_{DP}	PRD_{DT}
NPL_{AG}	16.6 %	7.1 %	0.9 %
NPL_{EN}	23.3 %	--	--
NPL_{FO}	--	--	14,7 %
NPL_{TM}	13.8 %	--	--

04

Results and Discussion



Results

- There is a statistically significant relationship between agriculture, energy, food and timber manufacturing NPLs and PRDs.
- A statistically significant relationship could not be determined between tourism and paper production NPLs and PRDs.
- Only food production NPLs is affected by average temperature deviation.
- The most effective PRD on NPLs is "severe weather events".

Discussion

- Analysis results need to be calibrated.
- The limited impact of severe weather events on the agricultural NPL may be a result of the prevalence of greenhouse cultivation in Antalya.
- Within the framework of the current findings, it is concluded that the effect of physical risk factors on the asset quality of the banking sector is limited in the province of Antalya.

Next...

- Confirmation of this study by other statistical studies or directly obtained statistics.
- Expanding the scope of the study by including other provinces and sectors.
- Improving the dataset by including other severe natural events such as landslides and wild fires.
- Including different dimensions in the analysis, such as large exposures and bio-diversity losses.
- Estimation of possible losses and damages related to physical risks with climate change scenario analysis and stress tests.
- Developing a uniform approach to be applied across the sector.

BANKING REGULATION AND SUPERVISION AGENCY

Thanks

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