Supplementary material B 1

The mathematical background of the results presented in Section 5.1 using the principal component analysis (PCA) and Cronbach's alpha.

The PCA is to examine item-correlations to reduce the information into a latent component. A high intercorrelation between items are assumed to measuring a similar concept and are thus grouped into the same latent component. Sources which are found to be significantly different from all other sources are suggested to be excluded. However, a PCA cannot provide any evidence whether the source is relevant for measuring flood resilience.

For performing the PCA we have also looked in detail at the significance of the elements of the correlation matrix, Meyer–Olkin measure of sampling adequacy (KMO) (Kaiser, 1970), diagonals of the anti-image correlation and the total explained variance. All the results presented in the next section fulfilled all the necessary requirements for performing the PCA and corresponding analysis (Field, 2009).

First, we look at a one-component PCA and found that for each capital the variance explained is between 30 and 50 percent. The one-component PCA with all 88 source of resilience explains 24% of the variance. While these values seem to be low it should be kept in mind that, given such a complex set of resilience dimensions for each capital measured in communities across the globe, the variance explained is expected to be small compared to single community analysis (Witten et al. 2014). Based on this and given the very good internal validity we therefore proceed with the PCA using the Kaiser Criterion which allows to consider for multiple components within the capitals of the FRMC framework.

We therefore perform a PCA using the Kaiser Criterion and included a Varimax rotation to increase the explained variances to the highest possible level. At this point we note that if multiple components are allowed within each capital an increase in explained variation has to be expected, as the larger number of components can account more for individual fluctuations in the sources of resilience.

By performing this analysis, we identified a structure of at least 18 sub-components for measuring flood resilience across the 5 capitals of the FRMC. With the 18 sub-components we can distinguish between specific dimensions within the FRMC. The PCA has also pointed towards a reduction of sources without losing much of the explained variance. Table B1.1 below shows the final results of the PCA with adjusted Cronbach's alpha in brackets.

Table B1.1 PCA component structure of the 5 capitals used by the FRMC including Kaiser Criterion with Varimax Rotation (Cronbach's alpha in brackets).

Capital	Sub-capitals	# Source	Mean
	Financial budget management (α= 0.815)	5	33
	Flood related financial management decisions (α= 0.799)	6	28

Financial Capital (α= 0.838)	Financial Safety Nets (α= 0.65)	2	6
	Financial market access (α= 0.817)	2	24
Human Capital (α= 0.790)	Health and education (α= 0.752)	5	55
	Vulnerability awareness (α= 0.645)	4	40
	Hazard awareness (α= 0.614)	3	42
	Exposure awareness	1	64
Natural Capital	Environmental perception (α= 0.801)	4	24
Physical Capital (α= 0.815)	Flood coping infrastructure (α= 0.781)	4	46
	Basic need infrastructure (α= 0.799)	5	40
	Emergency response infrastructure (α= 0.74)	4	34
Social Capital (α= 0.916)	Flood resilience governance (α= 0.924)	11	30
	Institutional capital (α= 0.807)	6	42
	Flood risk prediction (α= 0.624)	4	29
	Community engagement in flood resilience planning (α= 0.699)	2	30
	Contingency planning (α= 0.769)	3	21
	Security (α= 0.697)	2	35

Supplementary material B 2: Socio-economic variables

This section refers to Fig 3 and the corresponding analysis of cluster typology development of flood resilience community. It is the statistical requirement to define the clusters by the socioeconomic and flood resilience variables. To sum it up, Table B2.1 shows that all socioeconomic variables are significantly different from each other (reject the null hypothesis), except for the variable livelihood strategies in the manufacturing sector livelihood strategies in the service sector.

As this only shows the requirements for statistical typology definition Table B2.2-9 provide the statistical description differences between each cluster.

Hypothesis Test Summary

Table B2.1 Hypothesis Test Summary using the Kruskal-Wallis Test to test the hypothesis of different socioeconomic variables in the four cluster. Note: Asymptotic significances are displayed. The significance level is .050.

Null Hypothesis	Test	Sig.	Decision
The distribution of Education is the same across categories of cluster	Independent-Samples Kruskal-Wallis Test	0.000	Reject the null hypothesis.
The distribution of poor share pf people living in community is the same across categories of cluster	Independent-Samples Kruskal-Wallis Test	0.000	Reject the null hypothesis.
The distribution of Livelihood strategy agricultural sector is the same across categories of cluster	Independent-Samples Kruskal-Wallis Test	0.000	Reject the null hypothesis.
The distribution of Livelihood strategy manufacturing sector is the same across categories of cluster	Independent-Samples Kruskal-Wallis Test	0.464	Retain the null hypothesis.
The distribution of Livelihood strategy service sector is the same across categories of cluster.	Independent-Samples Kruskal-Wallis Test	0.000	Reject the null hypothesis.
The distribution of Livelihood strategy service sector is the same across categories of cluster	Independent-Samples Kruskal-Wallis Test	0.493	Retain the null hypothesis.
The distribution of settlement types is the same across categories of cluster	Independent-Samples Kruskal-Wallis Test	0.000	Reject the null hypothesis.
The distribution of flood exposure in last 10 years is the same across categories of cluster	Independent-Samples Kruskal-Wallis Test	0.000	Reject the null hypothesis.

Independent-Samples Kruskal-Wallis Test

Table B2.2 Education rate: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Total N	**118**
Test Statistic	27.541[a]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	0.000
a. The test statistic is adjusted for ties.	

Pairwise Comparisons of the four clusters					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster 1 /Cluster 3	30.409	9.431	3.224	0.001	0.008
Cluster 1/Cluster 4	-34.642	11.123	-3.114	0.002	0.011
Cluster 1/Cluster 2	41.044	7.949	5.164	0.000	0.000
Cluster 3/Cluster 4	-4.232	11.494	-0.368	0.713	1.000
Cluster 3/Cluster 2	-10.635	8.460	-1.257	0.209	1.000
Cluster 4/Cluster 2	6.403	10.312	0.621	0.535	1.000
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.					
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.					

Table B2.3 Poor income class of people living in the community: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Total N	**118**
Test Statistic	43.459[a]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	0.000
a. The test statistic is adjusted for ties.	

Pairwise Comparisons of Cluster Profiles					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster 3/Cluster 4	-35.964	11.493	-3.129	0.002	0.011

Cluster 3/Cluster 2	-38.245	8.460	-4.521	0.000	0.000
Cluster 3/Cluster 1	-61.862	9.431	-6.560	0.000	0.000
Cluster 4/Cluster 2	2.281	10.311	0.221	0.825	1.000
Cluster4/Cluster 1	25.898	11.122	2.329	0.020	0.119
Cluster2/Cluster1	-23.617	7.948	-2.971	0.003	0.018

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table B2.4 Livelihood strategy agricultural sector: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Total N	**118**
Test Statistic	38.853[a]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	0.000

a. The test statistic is adjusted for ties.

Pairwise Comparisons of Cluster Profiles

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster 3/Cluster 4	-38.339	11.481	-3.339	0.001	0.005
Cluster 3/Cluster 2	-49.429	8.451	-5.849	0.000	0.000
Cluster 3/Cluster 1	-49.694	9.421	-5.275	0.000	0.000
Cluster 4/Cluster 2	11.090	10.301	1.077	0.282	1.000
Cluster4/Cluster 1	11.355	11.110	1.022	0.307	1.000
Cluster2/Cluster1	-0.265	7.940	-0.033	0.973	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table B2.5 L Livelihood strategy production sector: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Total N	118
Test Statistic	2.565[a,b]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	0.464

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Table B2.6 Livelihood strategy service sector: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Total N	118
Test Statistic	18.877[a]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	0.000
a. The test statistic is adjusted for ties.	

Pairwise Comparisons of Cluster Profiles					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster2/Cluster 1	-5.301	7.950	-0.667	0.505	1.000
Cluster2/Cluster4	-10.814	10.314	-1.049	0.294	1.000
Cluster2/Cluster3	36.067	8.462	4.263	0.000	0.000
Cluster1/Cluster4	-5.514	11.125	-0.496	0.620	1.000
Cluster1/Cluster3	30.767	9.433	3.262	0.001	0.007
Cluster4/Cluster3	25.253	11.496	2.197	0.028	0.168
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.					
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.					

Table B2.7 Livelihood strategy savings/retirements: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Total N	**118**
Test Statistic	2.403[a,b]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	0.493
a. The test statistic is adjusted for ties.	
b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.	

Table B2.8 Settlement types across cluster profiles: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Pairwise Comparisons of Cluster Profiles					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster1/Cluster2	1.640	7.288	0.225	0.822	1.000
Cluster1/Cluster4	-12.054	10.199	-1.182	0.237	1.000
Cluster1/Cluster3	45.941	8.648	5.312	0.000	0.000
Cluster2/Cluster 4	-10.415	9.455	-1.101	0.271	1.000
Cluster2/Cluster3	44.301	7.757	5.711	0.000	0.000
Custer4/Cluster3	33.887	10.539	3.215	0.001	0.008

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table 29 Flood exposure of last 10 years: Pairwise Comparisons of clusters using the Independent-Samples Kruskal-Wallis Test

Total N	118
Test Statistic	39.723[a]
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	0.000

a. The test statistic is adjusted for ties.

Pairwise Comparisons of Cluster Profiles

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster3/Cluster4	-44.256	11.145	-3.971	0.000	0.000
Cluster3/Cluster1	-44.912	9.145	-4.911	0.000	0.000
Cluster3/Cluster2	-49.752	8.204	-6.065	0.000	0.000
Cluster4/Cluster1	0.656	10.785	0.061	0.951	1.000
Cluster4/Cluster2	5.496	9.999	0.550	0.583	1.000
Cluster1/Cluster2	4.840	7.708	0.628	0.530	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Supplementary material B3:

This material refers to Section 6 and Fig. 4 in the paper.

Bi-variate statistical analysis

In the last step of the statistical analyses, interdependencies between the capitals as well as sub-capitals were examined and controlled by clusters. This approach puts into account that measuring flood resilience is context specific, but the dynamics of flood resilience may vary between different community clusters. For this investigation we use a bi-variate statistical analysis (Pearson correlation and significance test) to see the interactions of flood resilience functions. Table 11 shows the results of the total dataset of 118 communities. In Table 12 results are shown for the clustered bivariate analysis.

For interpretation of the dynamics between the different capitals we relied on visual examinations as well as employed classic linear regression models[1]. Figure 1 helps to understand the specific interdependencies and relations between flood resilience measures for each of the cluster profiles.

Table B3.1 Total dataset of 118 communities correlation analysis between five capitals. *. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).

Correlations						
		Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Financial Capital	Pearson Correlation	1	.668**	.501**	.720**	.775**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
Human Capital	Pearson Correlation	.668**	1	.304**	.673**	.636**
	Sig. (2-tailed)	0.000		0.001	0.000	0.000
Natural Capital	Pearson Correlation	.501**	.304**	1	.209*	.563**
	Sig. (2-tailed)	0.000	0.001		0.023	0.000
Physical Capital	Pearson Correlation	.720**	.673**	.209*	1	.643**
	Sig. (2-tailed)	0.000	0.000	0.023		0.000

[1] More advanced statistical methods such as structural equation modelling or using general linear models are difficult to apply in our case as, while the number of communities is exceptionally high compared to other studies, it is still not large enough for advanced statistical techniques that usually need a larger number of observations (e.g. for SEMs it should be at least above 300, for General Linear Models with at least one interaction term it should be at least above 250, see Backhaus et al. 2017).

Social Capital	Pearson Correlation	.775**	.636**	.563**	.643**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	

Table B3.2 Cluster 1 correlation analysis between five capitals. *. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed)

Correlations

Cluster 1		Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Financial Capital	Pearson Correlation	1	-0.199	0.083	0.286	0.195
	Sig. (2-tailed)		0.300	0.670	0.133	0.312
	N	29	29	29	29	29
Human Capital	Pearson Correlation	-0.199	1	0.087	-0.176	0.080
	Sig. (2-tailed)	0.300		0.653	0.360	0.681
	N	29	29	29	29	29
Natural Capital	Pearson Correlation	0.083	0.087	1	0.028	-.400*
	Sig. (2-tailed)	0.670	0.653		0.887	0.031
	N	29	29	29	29	29
Physical Capital	Pearson Correlation	0.286	-0.176	0.028	1	.380*
	Sig. (2-tailed)	0.133	0.360	0.887		0.042
	N	29	29	29	29	29
Social Capital	Pearson Correlation	0.195	0.080	-.400*	.380*	1
	Sig. (2-tailed)	0.312	0.681	0.031	0.042	
	N	29	29	29	29	29

Table B3.3 Cluster 2 correlation analysis between five capitals. *. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed)

Correlations

Cluster 2		Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Financial Capital	Pearson Correlation	1	0.047	0.169	.575**	.361**
	Sig. (2-tailed)		0.745	0.237	0.000	0.009
	N	51	51	51	51	51
Human Capital	Pearson Correlation	0.047	1	.310*	0.241	.349*
	Sig. (2-tailed)	0.745		0.027	0.088	0.012
	N	51	51	51	51	51
Natural Capital	Pearson Correlation	0.169	.310*	1	0.063	0.050
	Sig. (2-tailed)	0.237	0.027		0.660	0.730
	N	51	51	51	51	51
Physical Capital	Pearson Correlation	.575**	0.241	0.063	1	.495**
	Sig. (2-tailed)	0.000	0.088	0.660		0.000
	N	51	51	51	51	51
Social Capital	Pearson Correlation	.361**	.349*	0.050	.495**	1
	Sig. (2-tailed)	0.009	0.012	0.730	0.000	
	N	51	51	51	51	51

Table 3 Cluster 3 correlation analysis between five capitals. *. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed)

Correlations

Cluster 3		Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Financial Capital	Pearson Correlation	1	0.026	-0.331	0.119	0.108
	Sig. (2-tailed)		0.904	0.114	0.579	0.617
	N	24	24	24	24	24

Human Capital	Pearson Correlation	0.026	1	-.465*	0.402	.568**
	Sig. (2-tailed)	0.904		0.022	0.051	0.004
	N	24	24	24	24	24
Natural Capital	Pearson Correlation	-0.331	-.465*	1	-.577**	-0.400
	Sig. (2-tailed)	0.114	0.022		0.003	0.053
	N	24	24	24	24	24
Physical Capital	Pearson Correlation	0.119	0.402	-.577**	1	.535**
	Sig. (2-tailed)	0.579	0.051	0.003		0.007
	N	24	24	24	24	24
Social Capital	Pearson Correlation	0.108	.568**	-0.400	.535**	1
	Sig. (2-tailed)	0.617	0.004	0.053	0.007	
	N	24	24	24	24	24

Table B2.5 Cluster 4 correlation analysis between five capitals. *. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

Cluster 4		Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Financial Capital	Pearson Correlation	1	.773**	.837**	0.390	.700**
	Sig. (2-tailed)		0.001	0.000	0.168	0.005
	N	14	14	14	14	14
Human Capital	Pearson Correlation	.773**	1	.590*	.539*	.677**
	Sig. (2-tailed)	0.001		0.026	0.047	0.008
	N	14	14	14	14	14
Natural Capital	Pearson Correlation	.837**	.590*	1	0.454	0.455
	Sig. (2-tailed)	0.000	0.026		0.103	0.102
	N	14	14	14	14	14

Physical Capital	Pearson Correlation	0.390	.539*	0.454	1	0.186
	Sig. (2-tailed)	0.168	0.047	0.103		0.525
	N	14	14	14	14	14
Social Capital	Pearson Correlation	.700**	.677**	0.455	0.186	1
	Sig. (2-tailed)	0.005	0.008	0.102	0.525	
	N	14	14	14	14	14