Recent developments in cartography illustrated by the visualization of origin-destination matrix data

Menno-Jan Kraak

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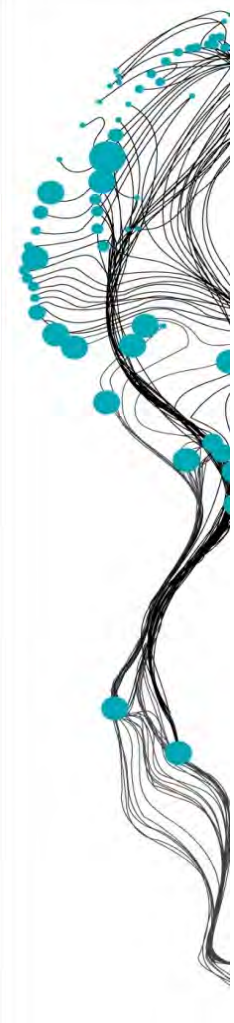

Recent developments in cartography illustrated by the visualization of the origin-destination matrix

- ICA
- Cartography

- Movement
- Visualization options for origin - destination

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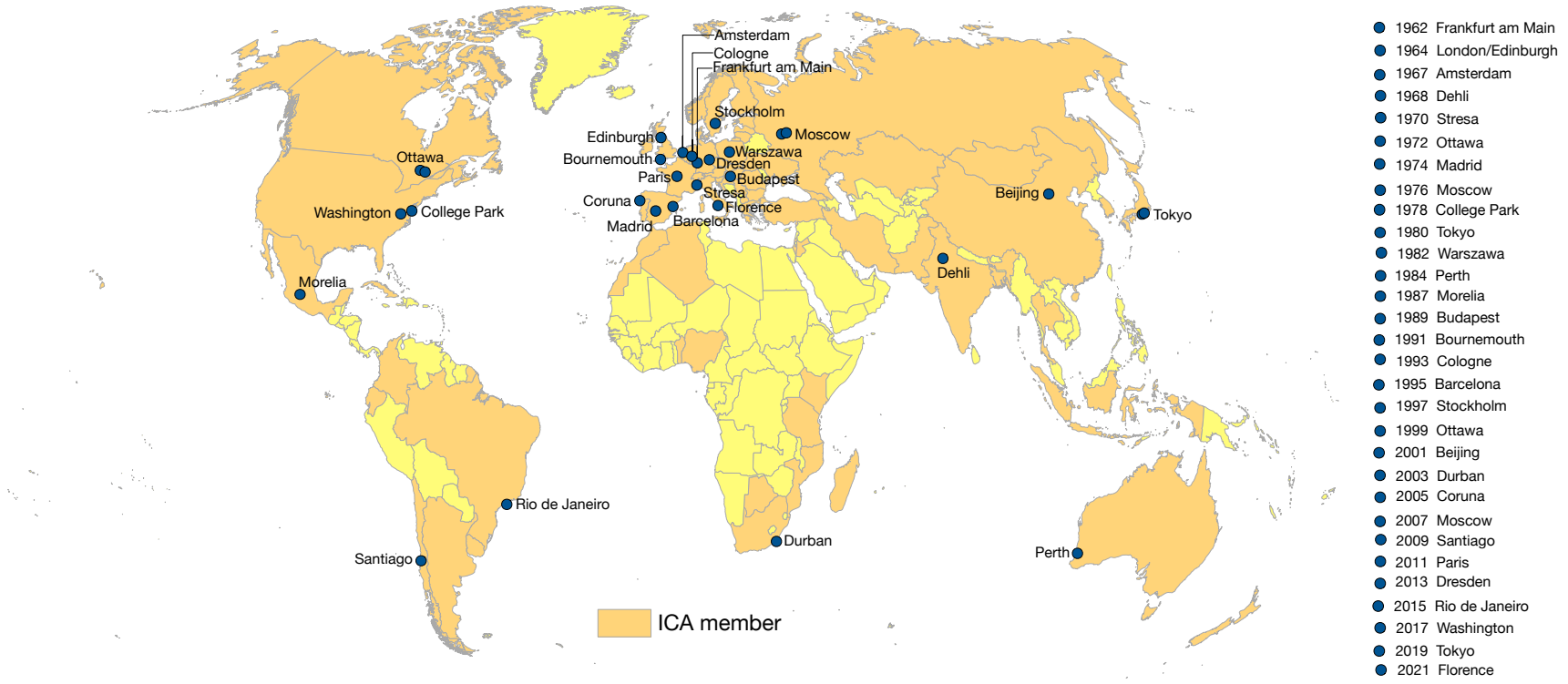
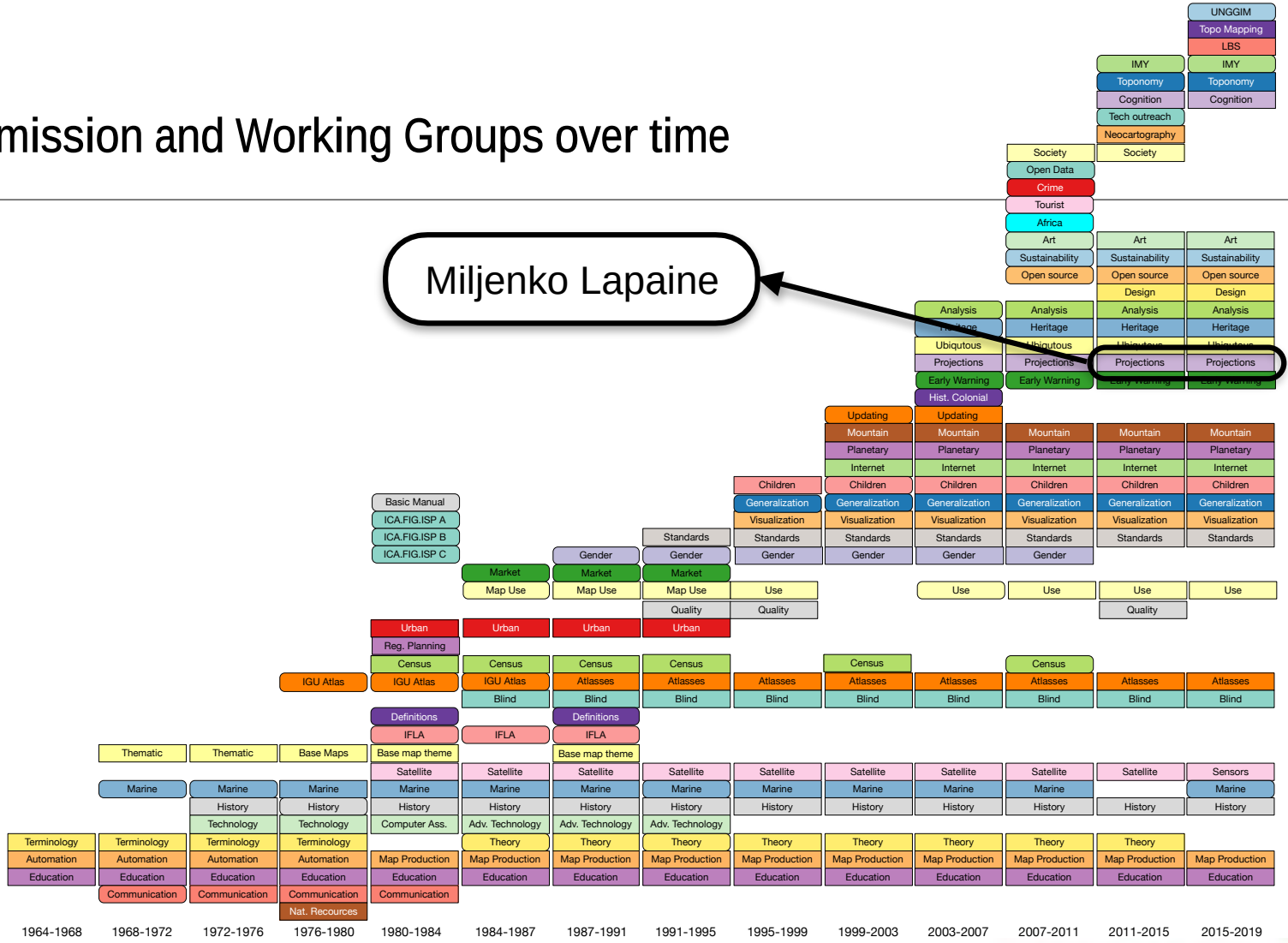
ICA's Members and International Cartographic Conferences

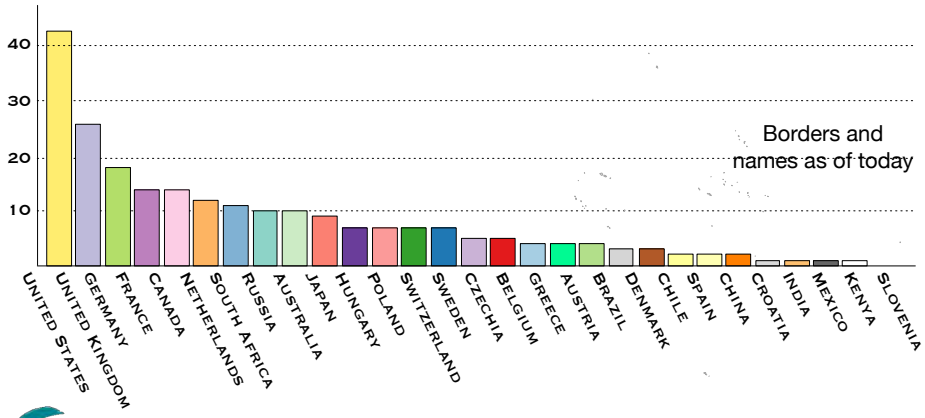


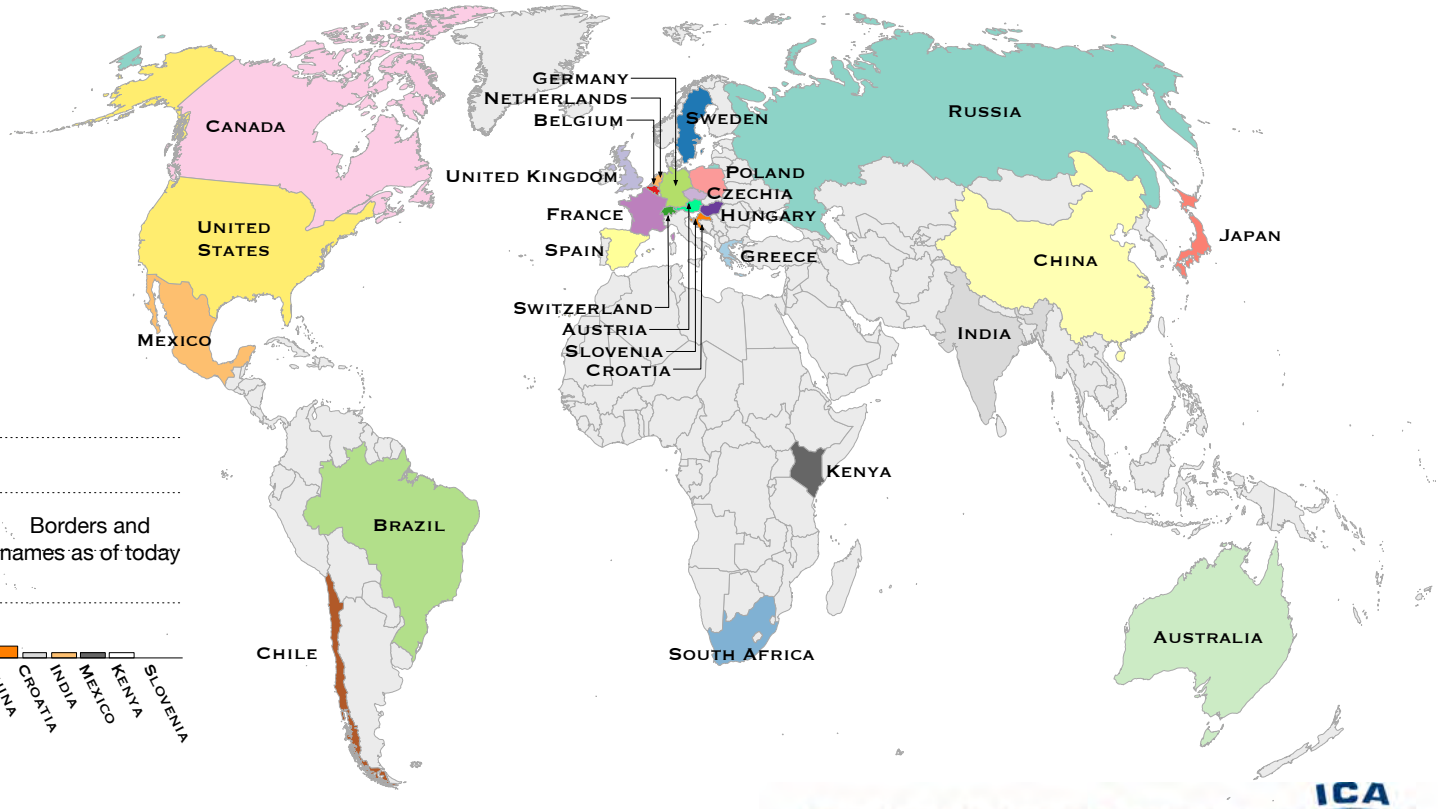
- 1962 Frankfurt am Main
- 1964 London/Edinburgh
- 1967 Amsterdam
- 1968 Dehli
- 1970 Stresa
- 1972 Ottawa
- 1974 Madrid
- 1976 Moscow
- 1978 College Park
- 1980 Tokyo
- 1982 Warszawa
- 1984 Perth
- 1987 Morelia
- 1989 Budapest
- 1991 Bournemouth
- 1993 Cologne
- 1995 Barcelona
- 1997 Stockholm
- 1999 Ottawa
- 2001 Beijing
- 2003 Durban
- 2005 Coruna
- 2007 Moscow
- 2009 Santiago
- 2011 Paris
- 2013 Dresden
- 2015 Rio de Janeiro
- 2017 Washington
- 2019 Tokyo
- 2021 Florence

Commission and Working Groups over time



Origin of Commission and Working Group Chairs





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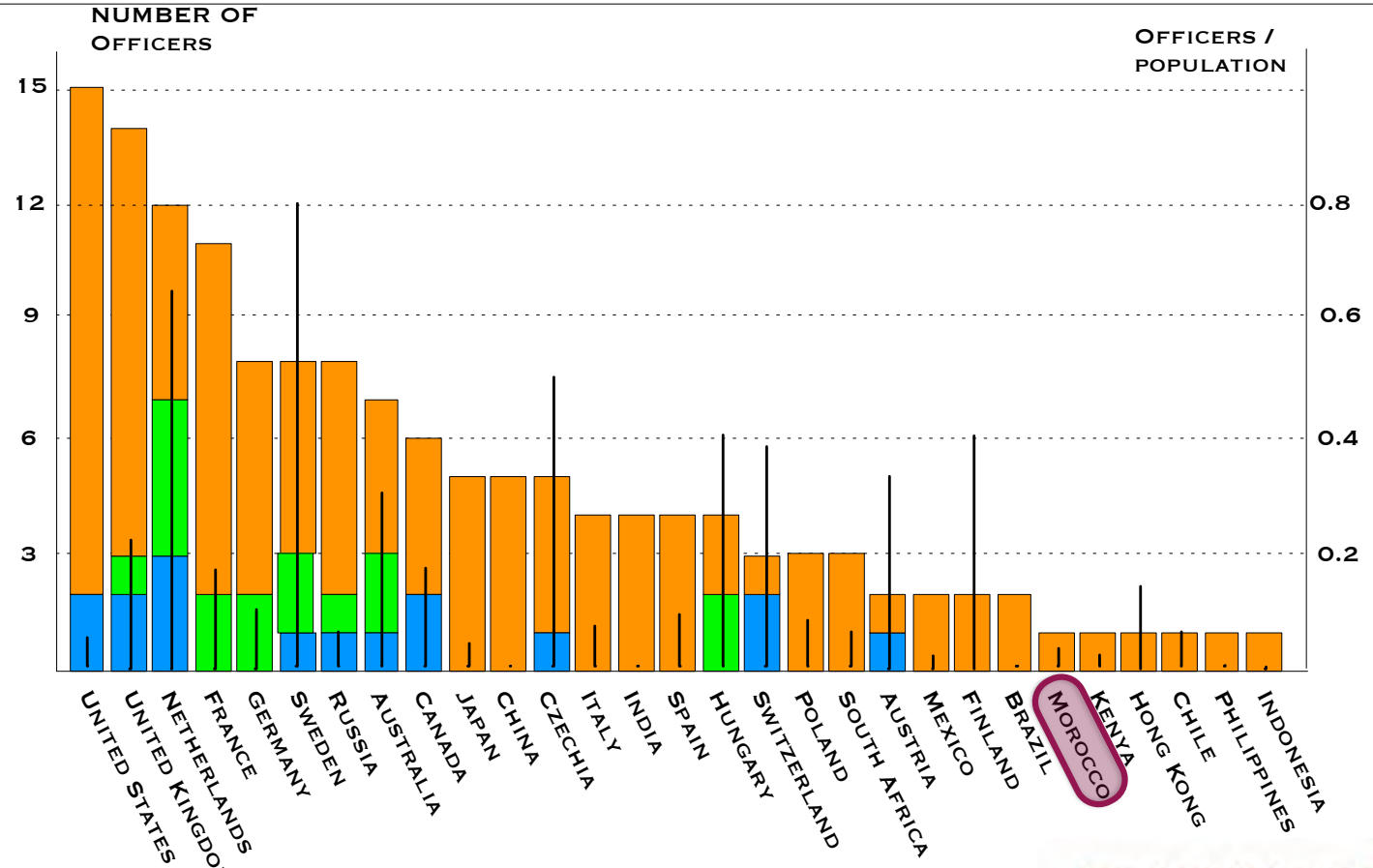
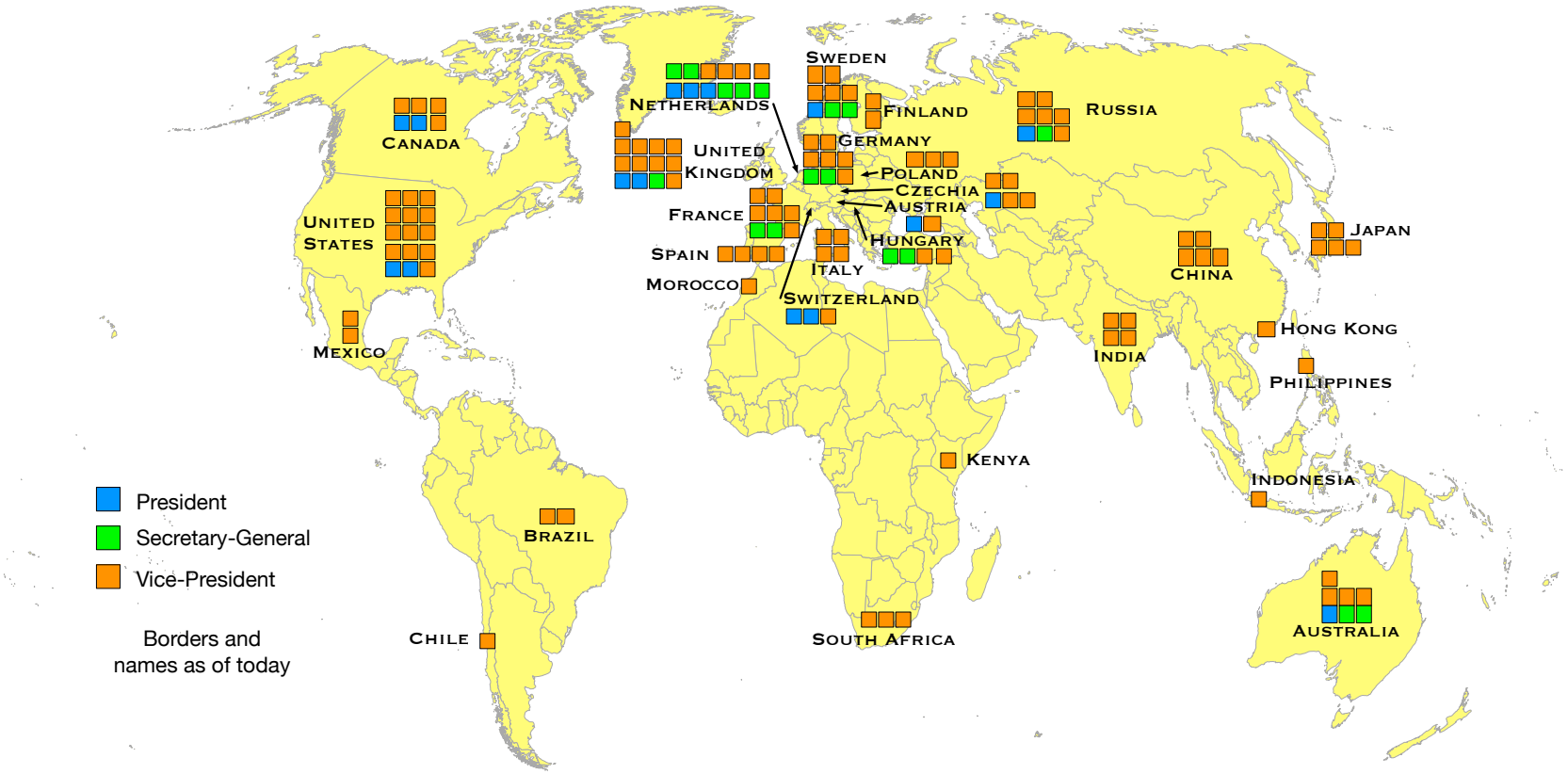
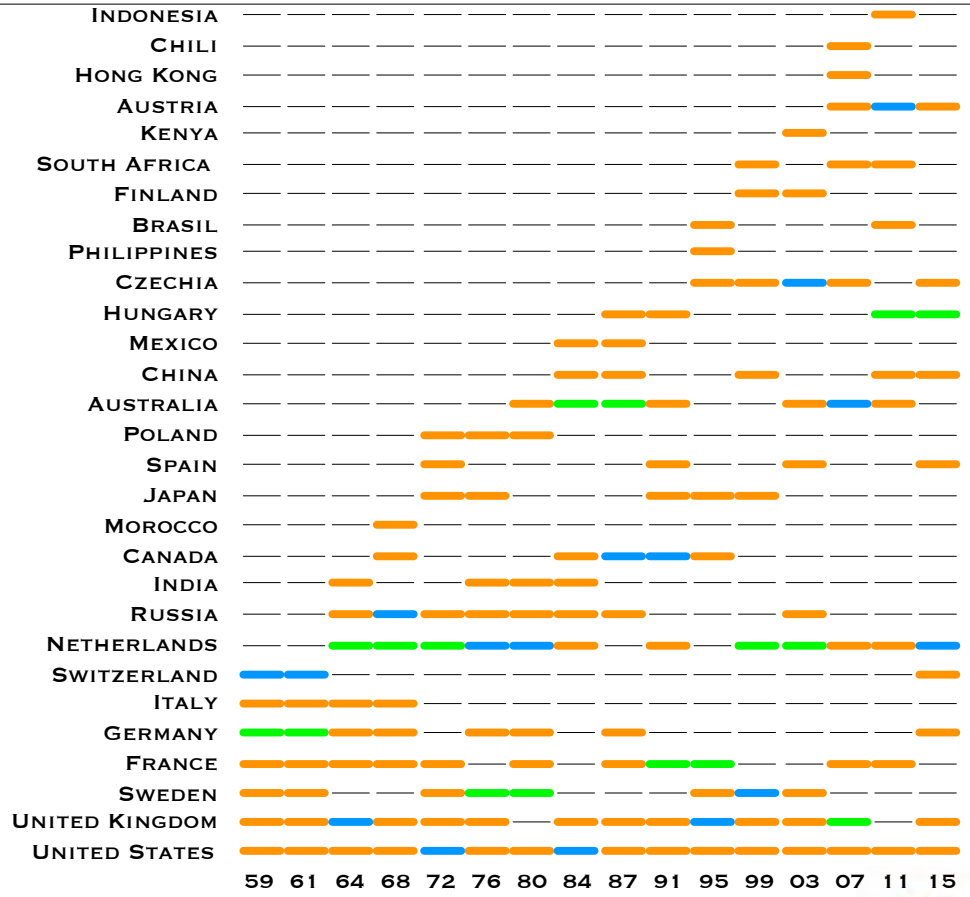
Number of Executive Committee members by country



Location Executive Committee members over time



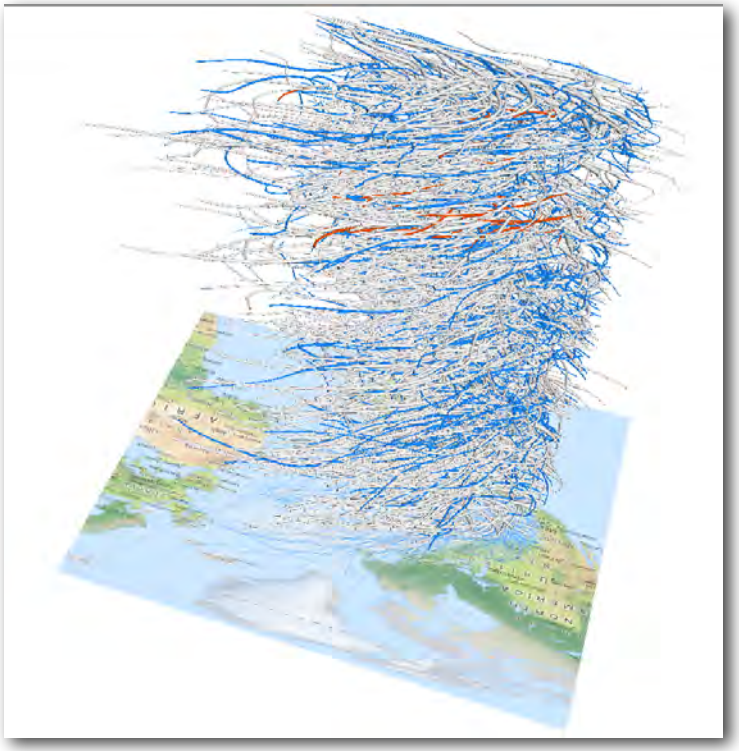
Executive Committee members by country over time



Kraak, M.J. & S.I. Fabrikant / Of Maps, Cartography, and the Geography of the International Cartographic Association (submitted ICY) / Data collected by Data: Igor Drecki / University of Auckland (NZ)

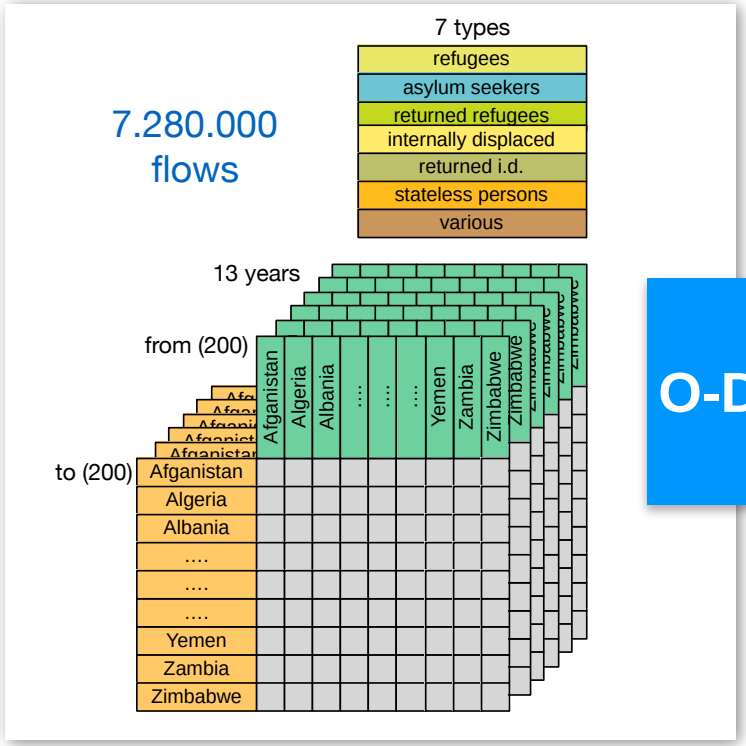
Origin-Destination Matrix

Movement basics



[20 years hurricane paths; Turdukulov and Restios, 2013)

continuous



(http://popstats.unhcr.org/)

discrete

O-D matrix

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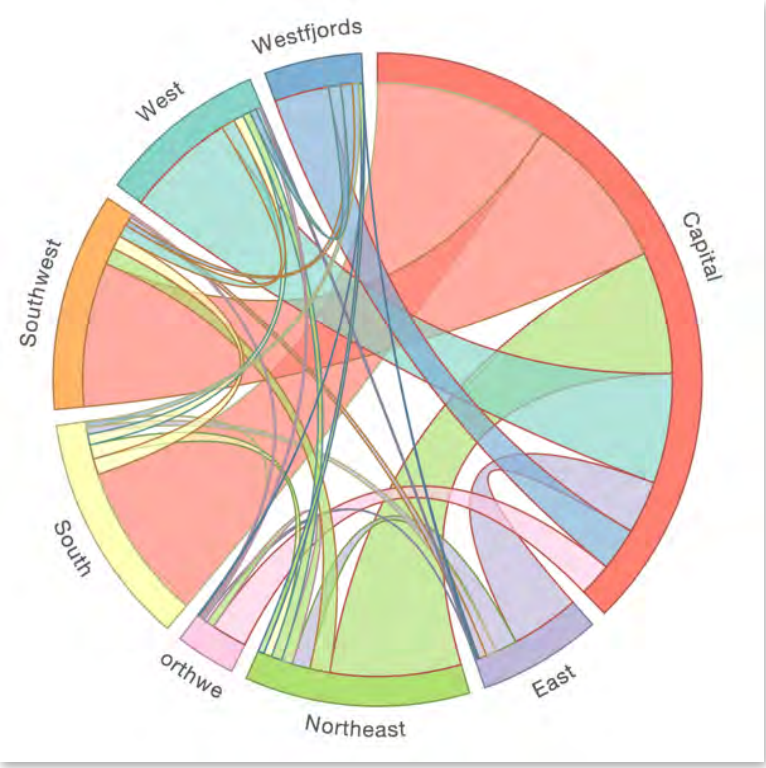
Migration in Iceland

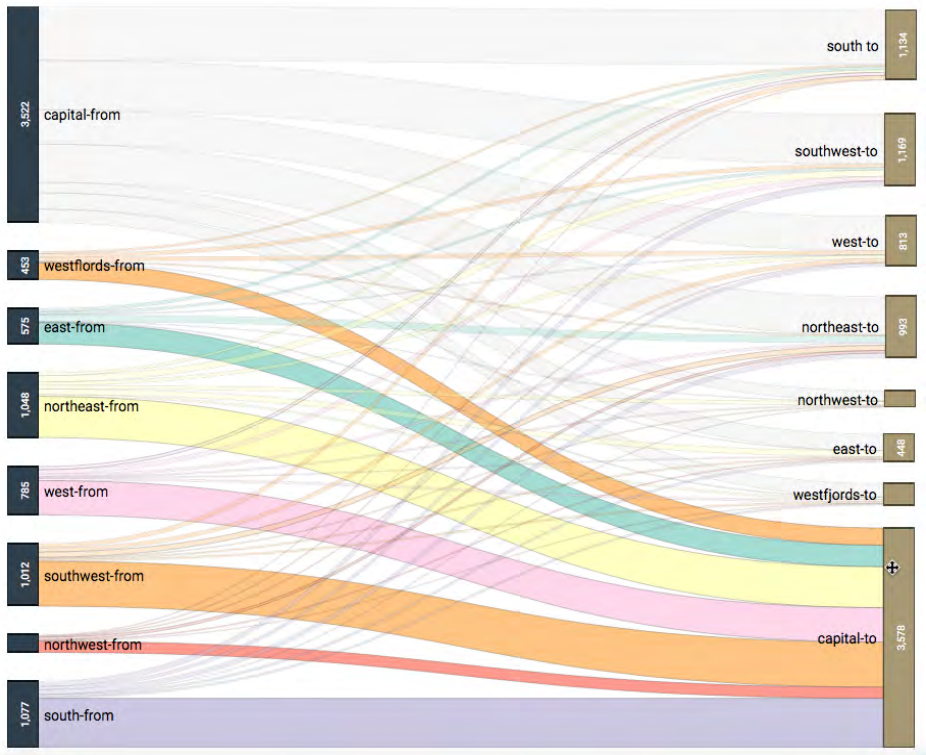
f \ t	Capital	East	Northeast	Northwest	South	Southwest	West	Westfjords
Capital	0	269	622	170	880	804	559	218
East	351	0	112	1	51	41	9	10
Northeast	670	91	0	58	42	103	54	30
Northwest	182	18	41	0	9	12	13	5
South	804	34	73	6	0	81	53	26
Southwest	733	22	85	13	69	0	63	27
West	560	12	40	19	51	69	0	34
Westfjords	278	2	20	0	32	59	62	0

O-D matrix

Capital
East
Northeast
Northwest
South
Southwest
West
Westfjords
Capital
East
Northeast
Northwest
South
Southwest
West
Westfjords
>670
351-670
>350

Chord diagram and Sankey diagram





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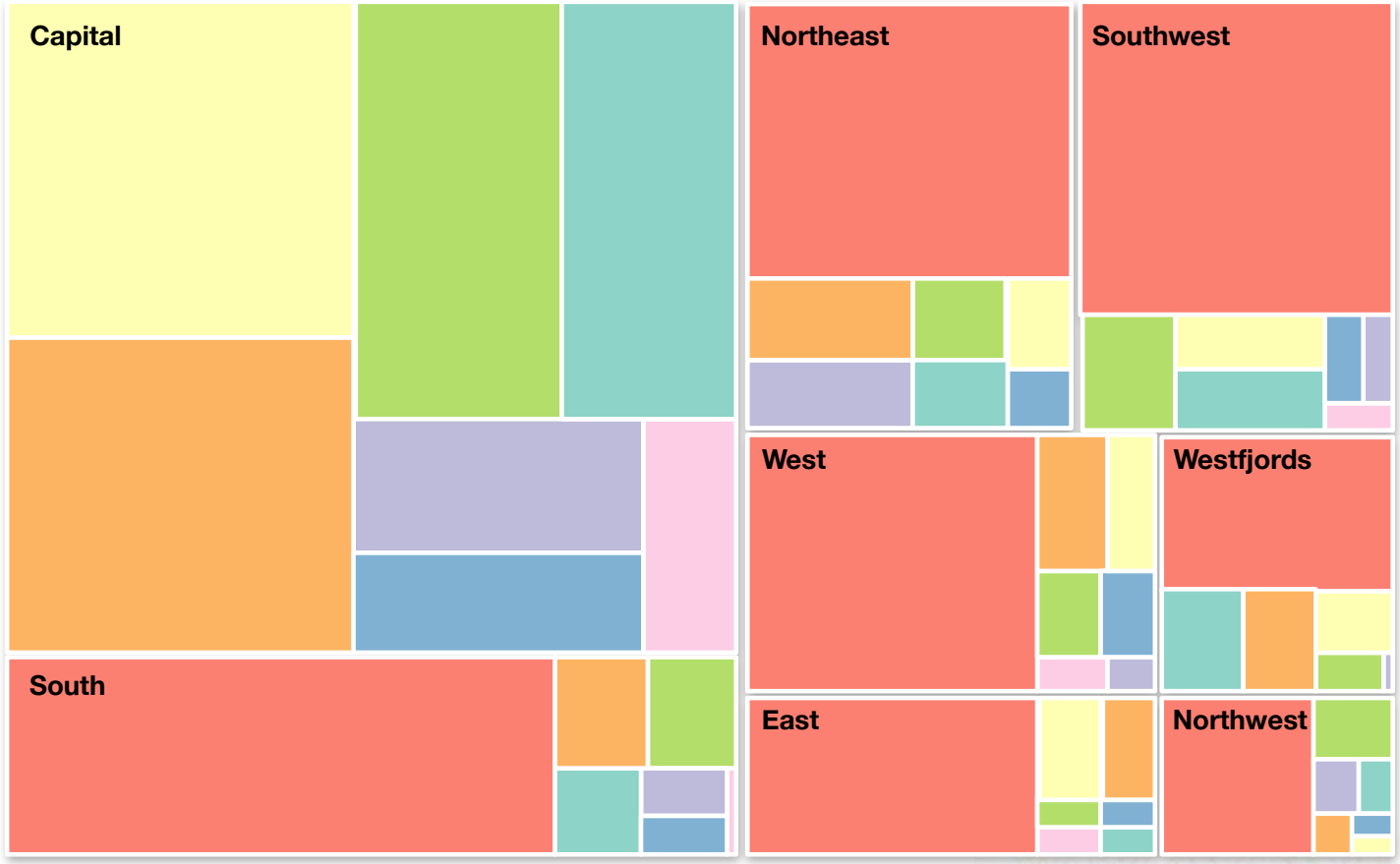
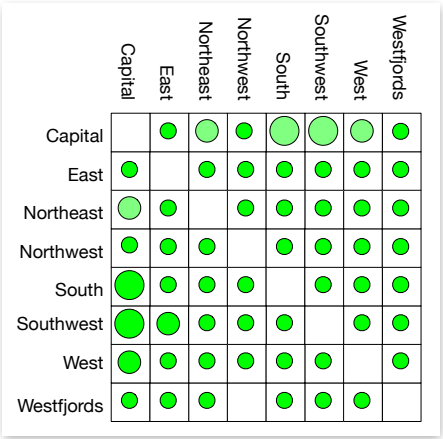
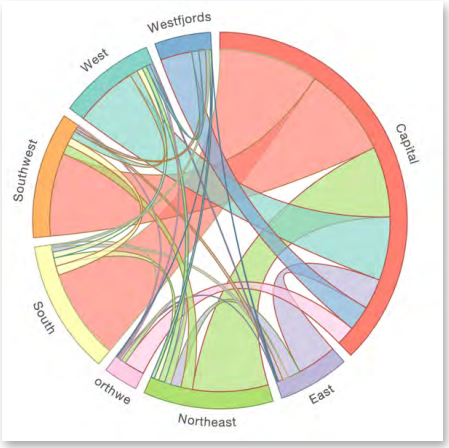
Treemap

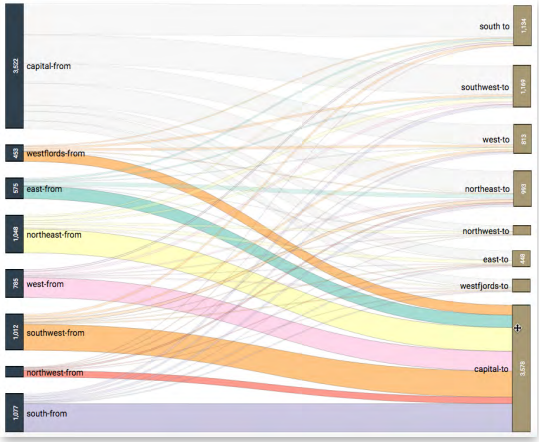

Capital
Northeast
Southwest
West
Westfjords
South
East
Northwest

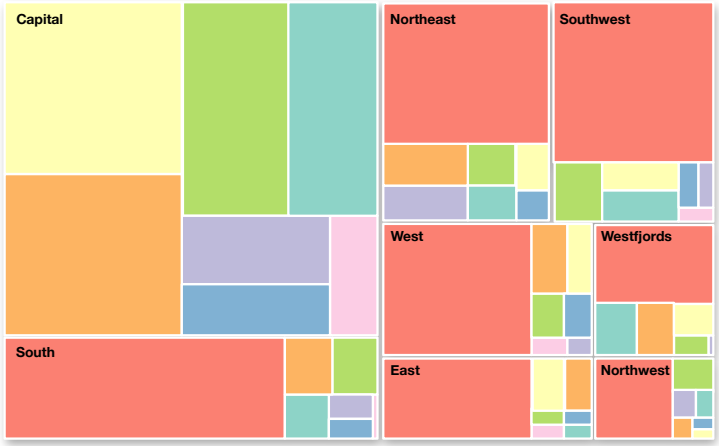
Lost geography

- Alphabetical order?









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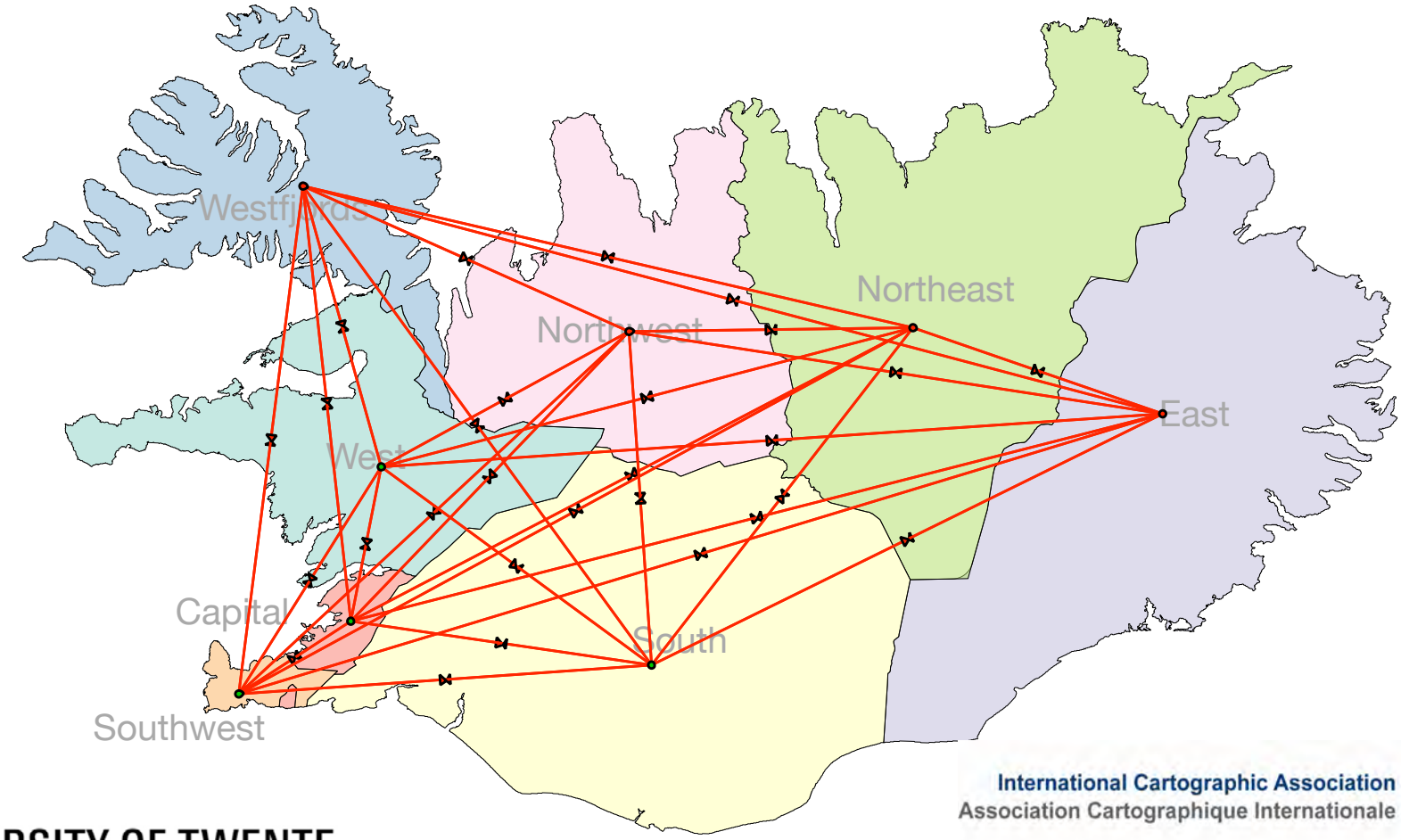
O-D network and the geography



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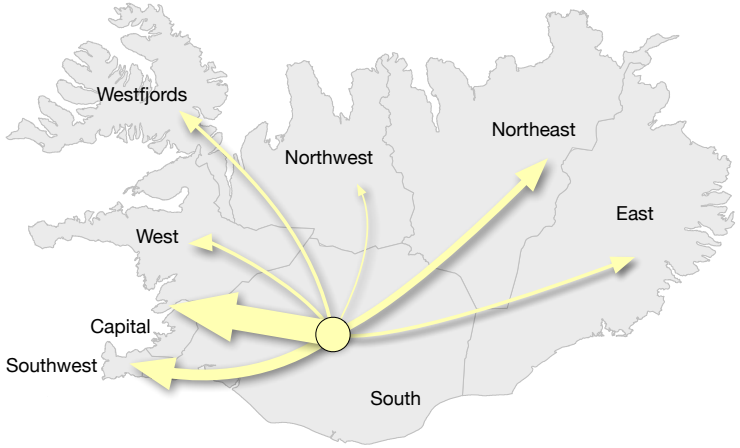
From one origin to all destination



f \ t	Capital	East	Northeast	Northwest	South	Southwest	West	Westfjords
Capital	0	269	622	170	880	804	559	218
East	351	0	112	1	51	41	9	10
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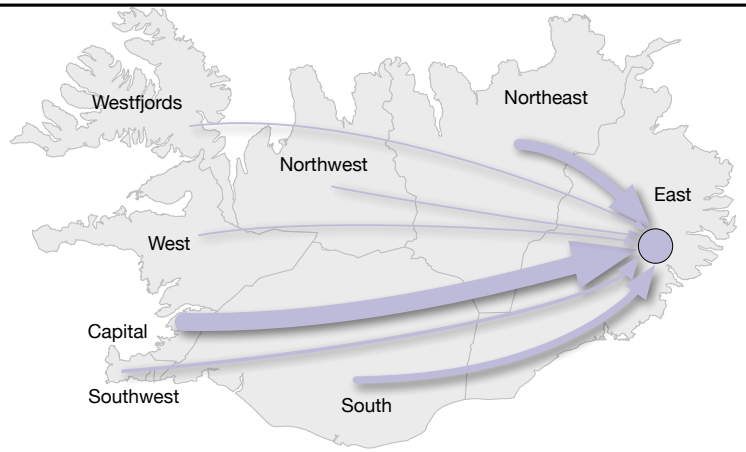
Southwest	733	22	85	13	69	0	63	27
West	560	12	40	19	51	69	0	34
Westfjords	278	2	20	0	32	59	62	0

From all origins to one destination



f \ t	Capital	East	Northeast	Northwest	South	Southwest	West	Westfjords
Capital	0	269	622	170	880	804	559	218
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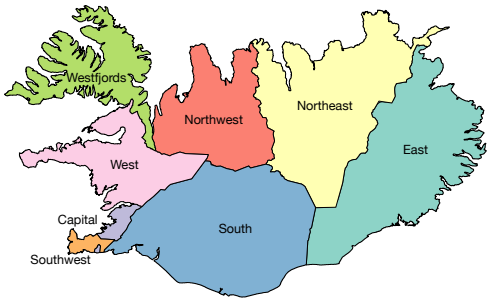
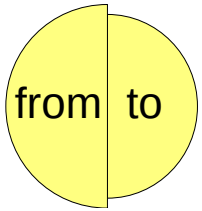
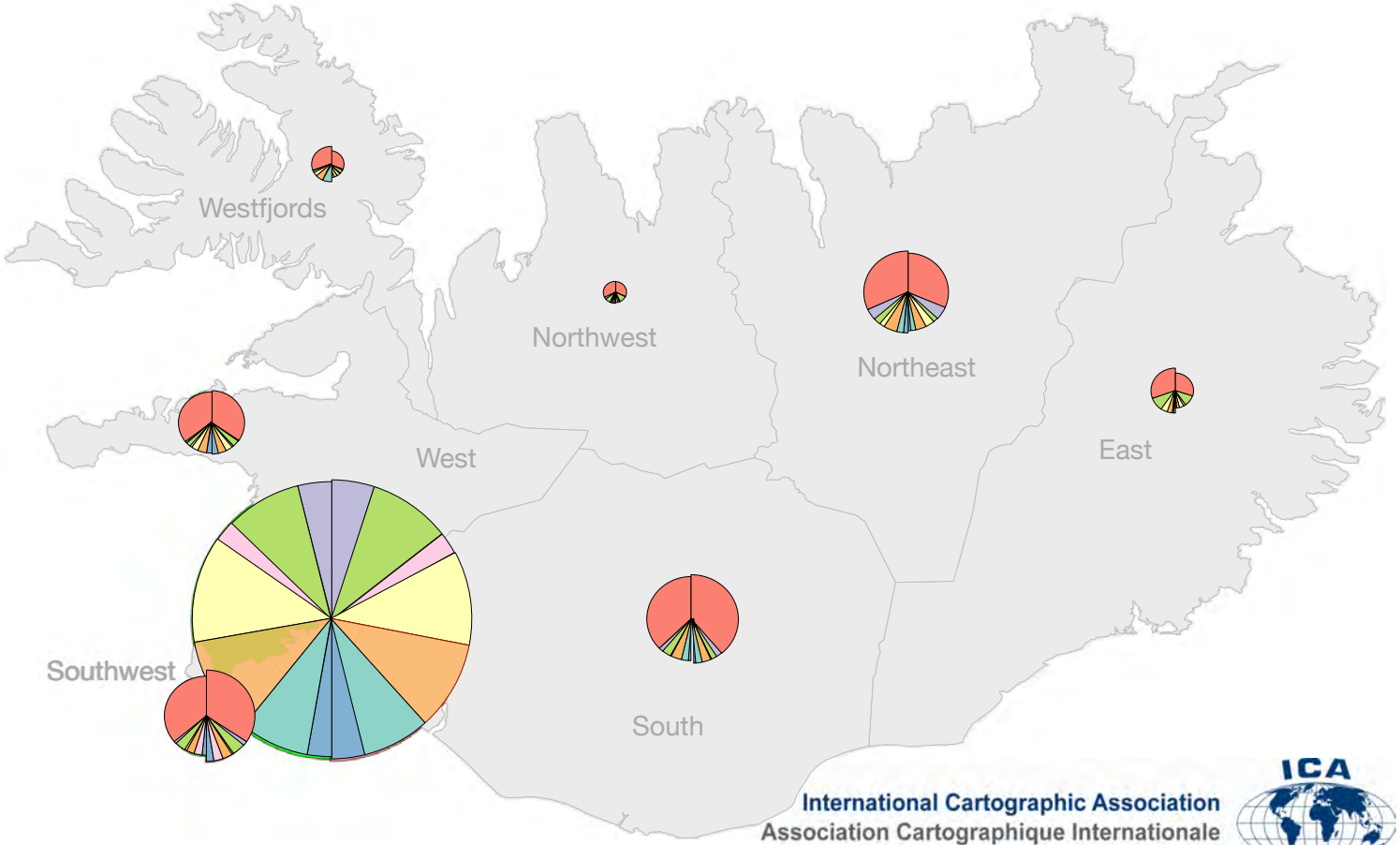
West	560	12	40	19	51	69	0	34
Westfjords	278	2	20	0	32	59	62	0

Migration from (left) and to (right)







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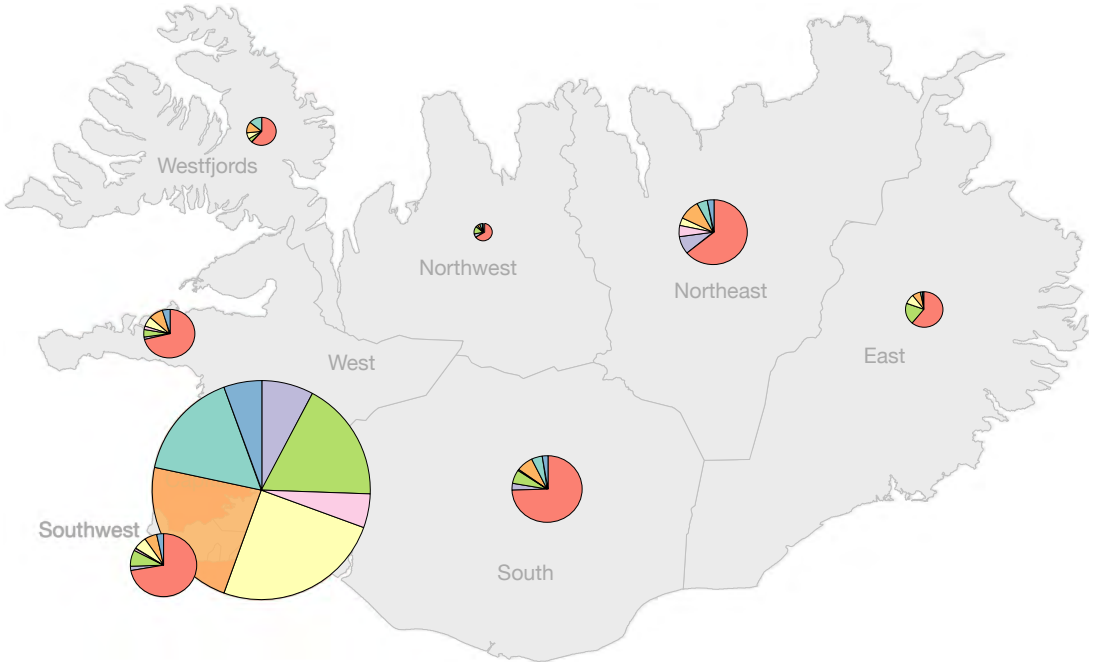
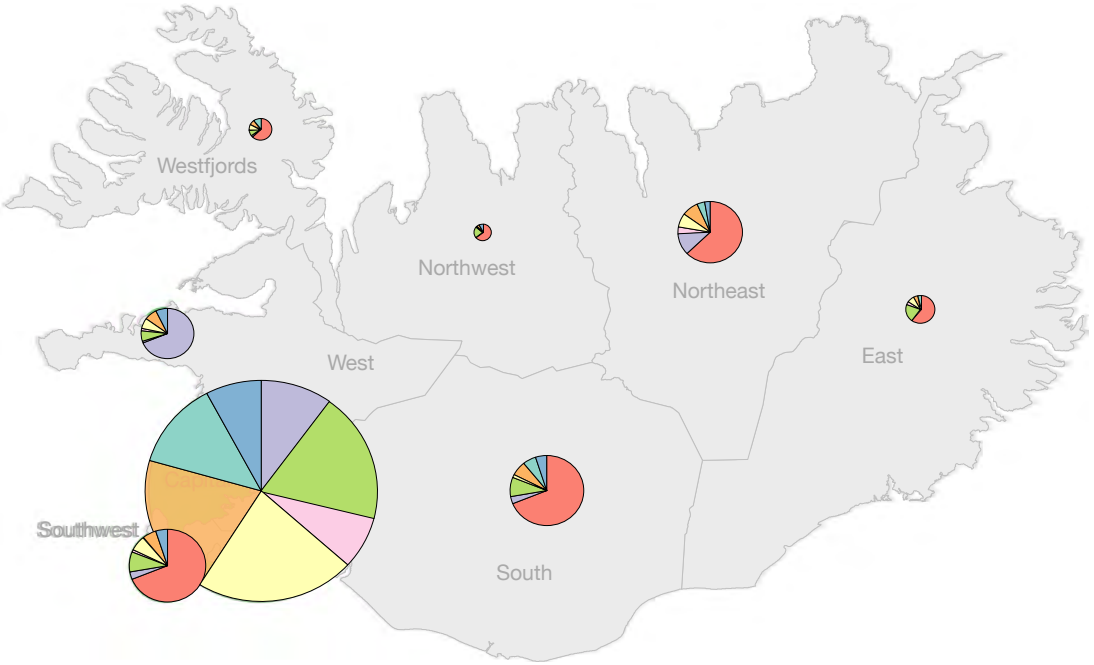
Migration from (left) and to (right)





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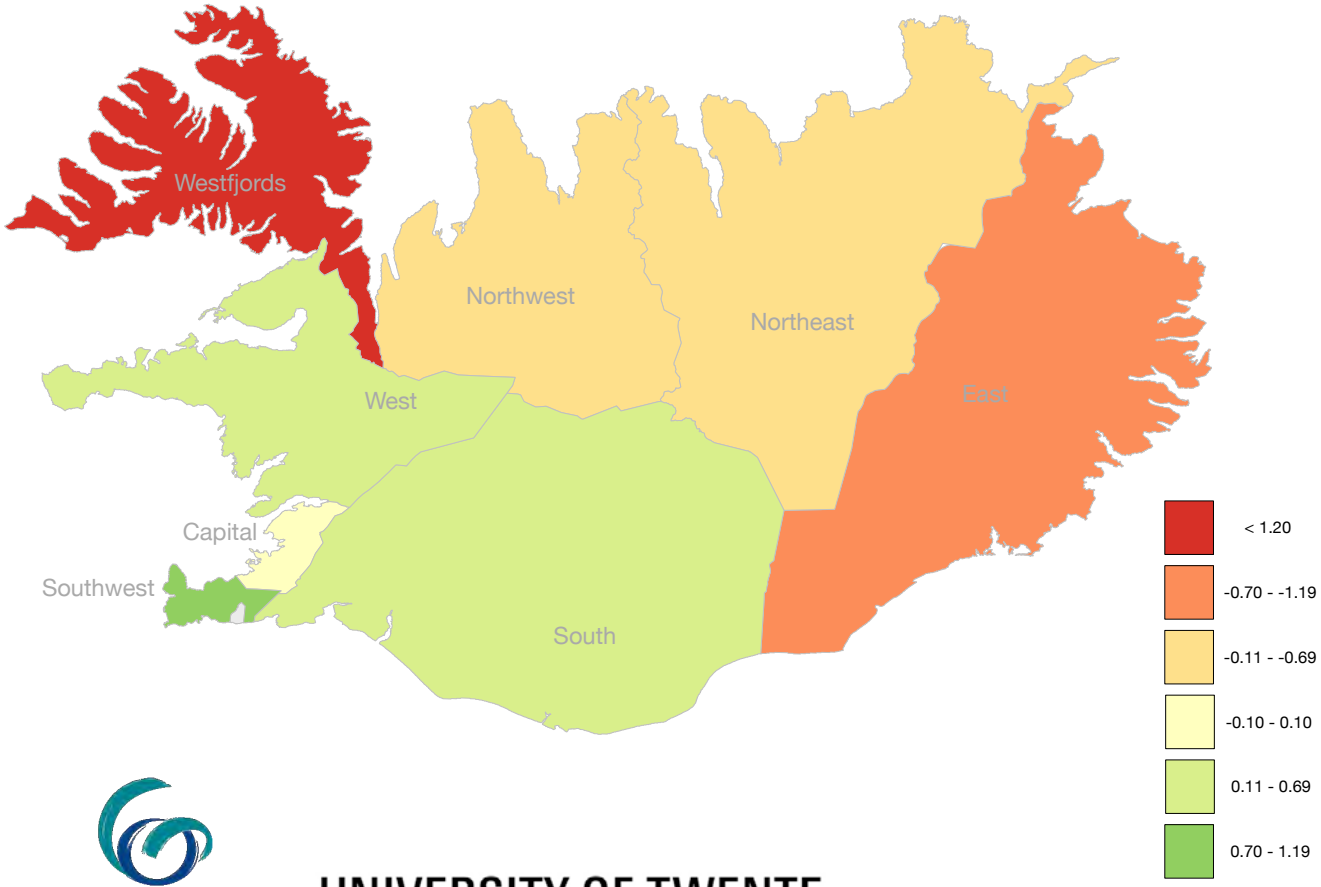
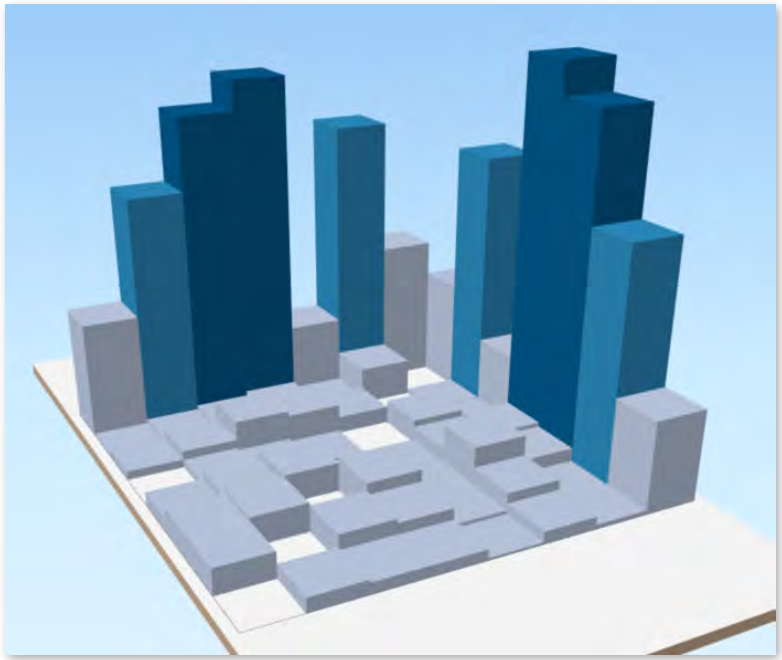
Relative and absolute migration





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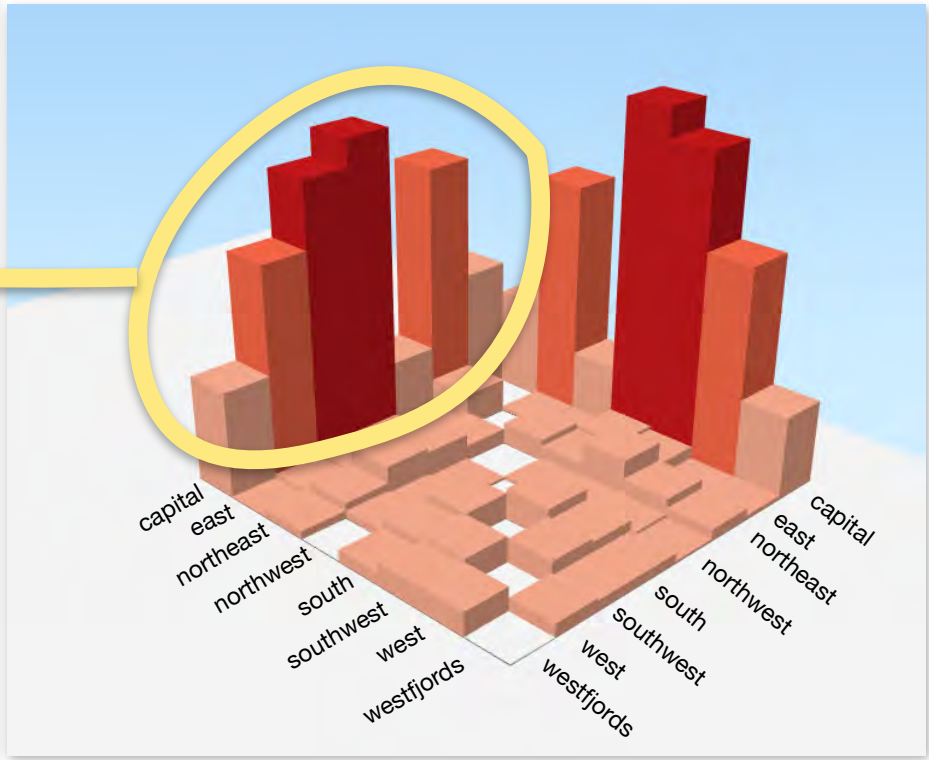
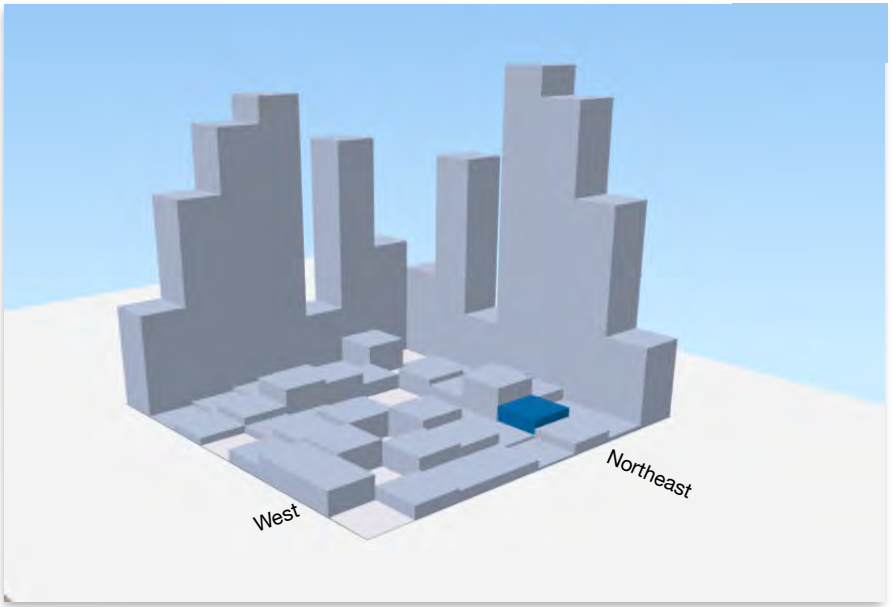
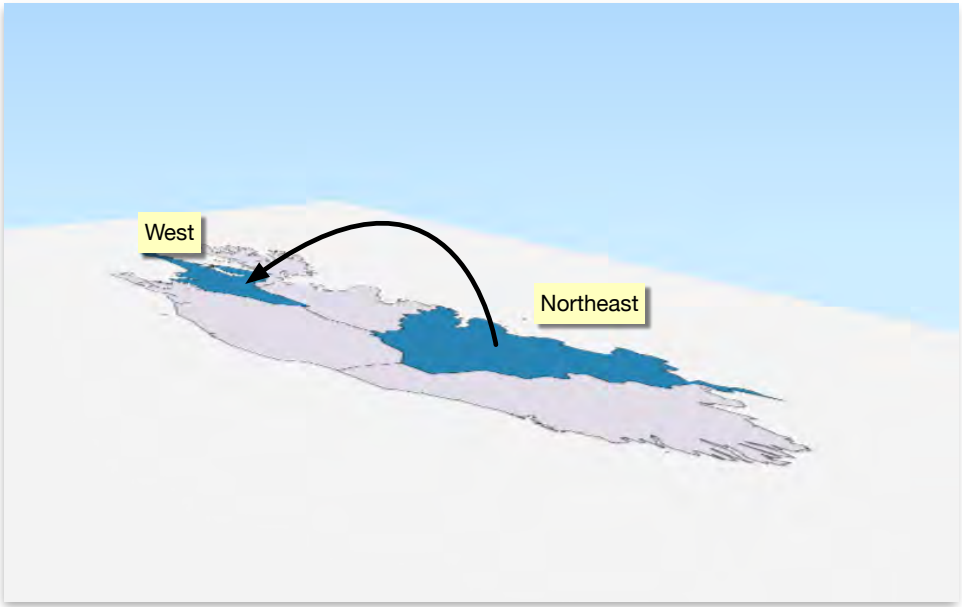
3D O-D matrix

All is relative

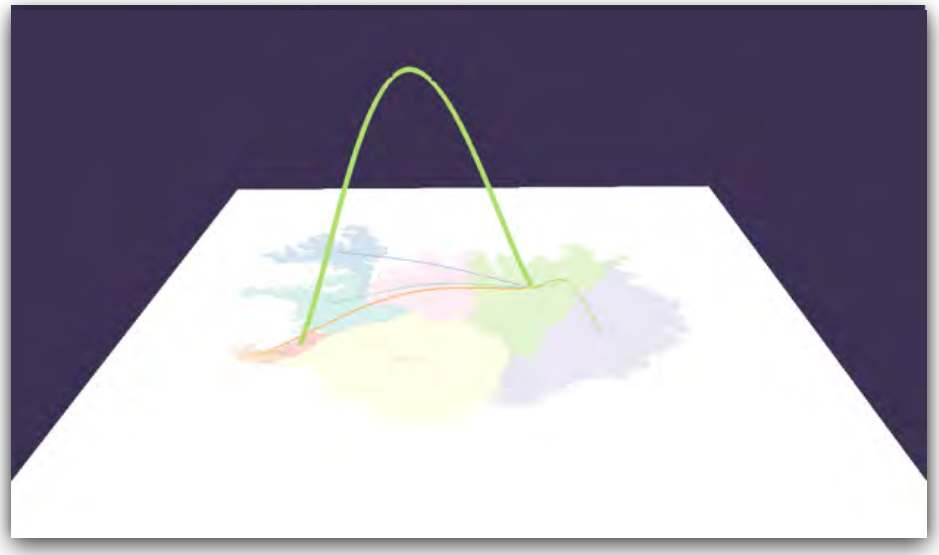


Link OD matrix and map





(3D) map



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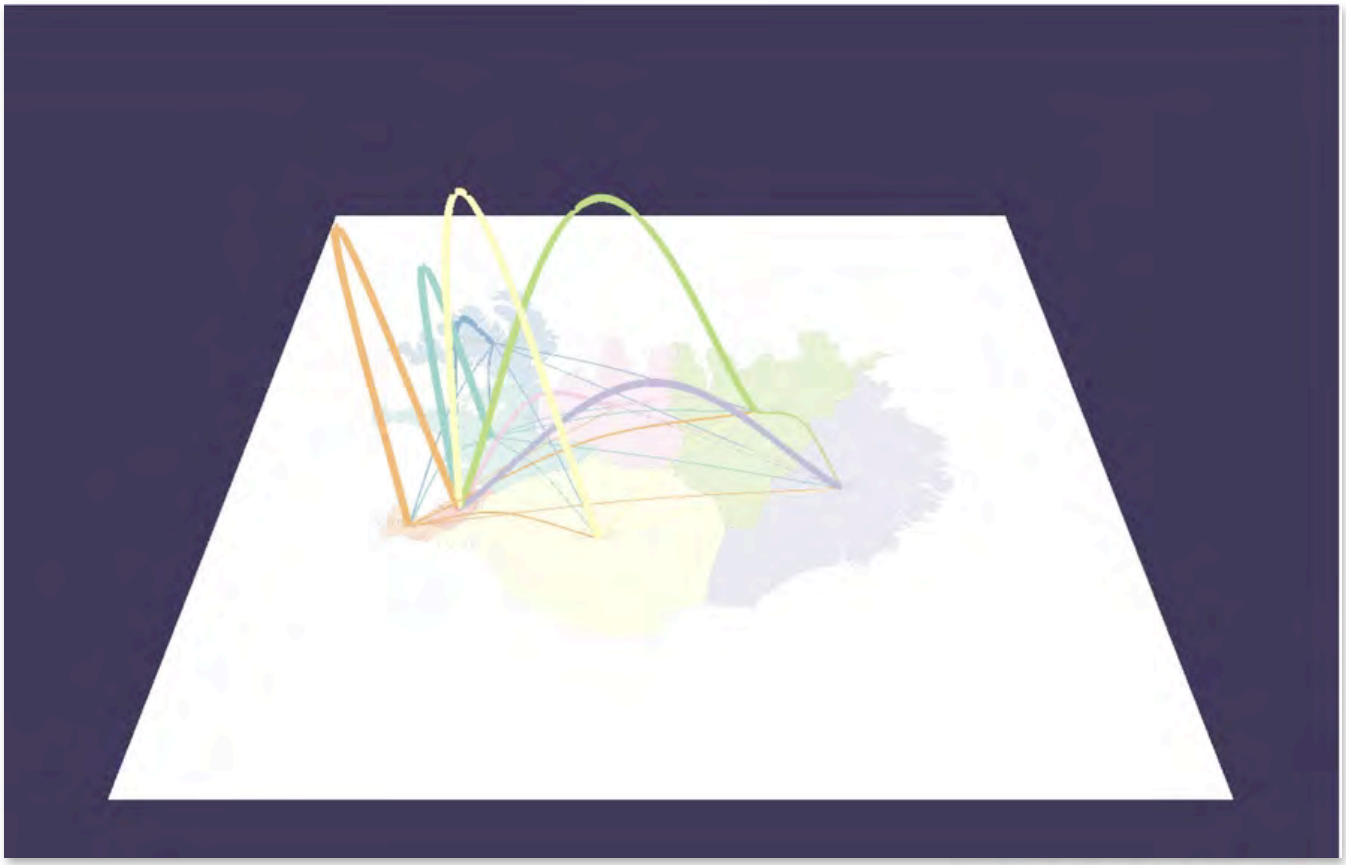
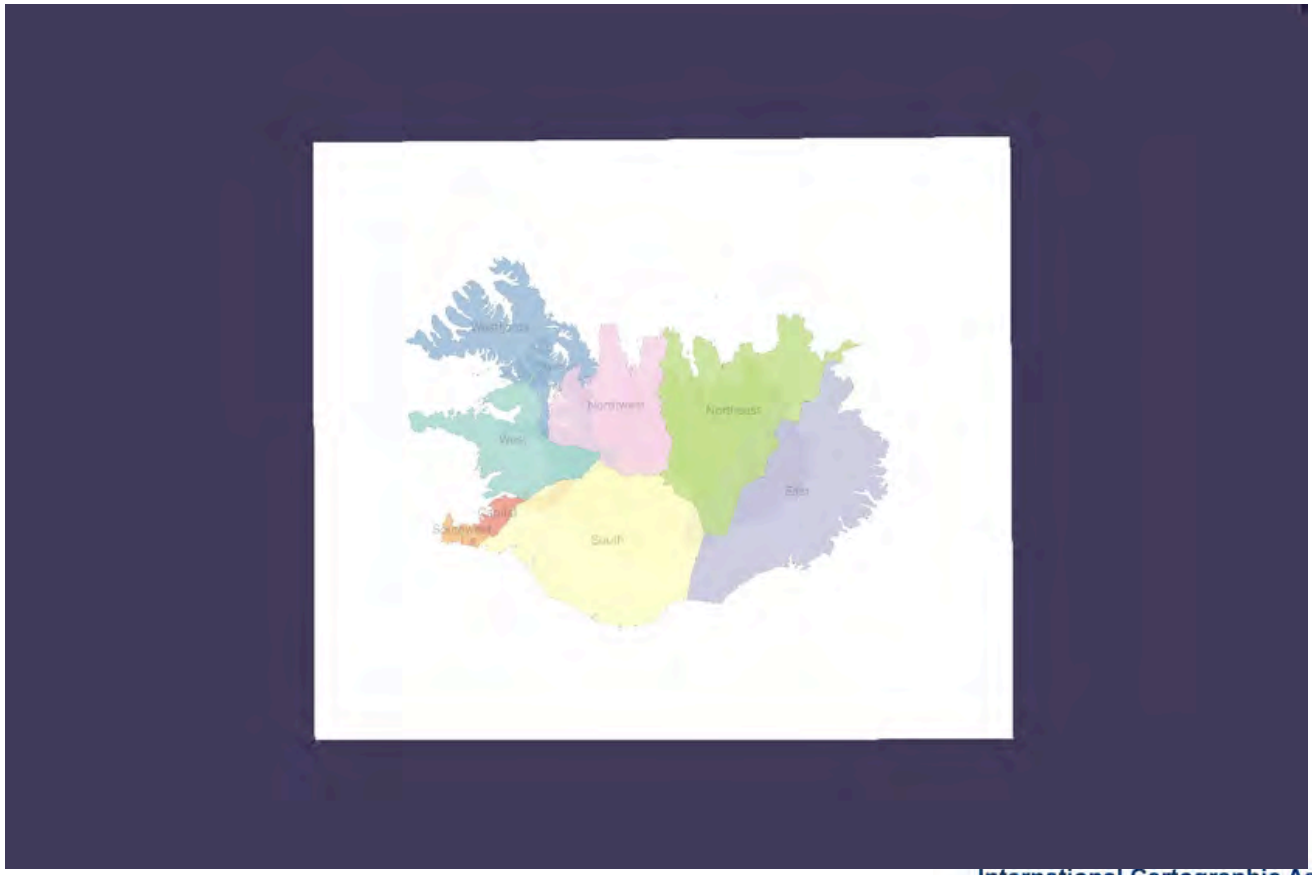
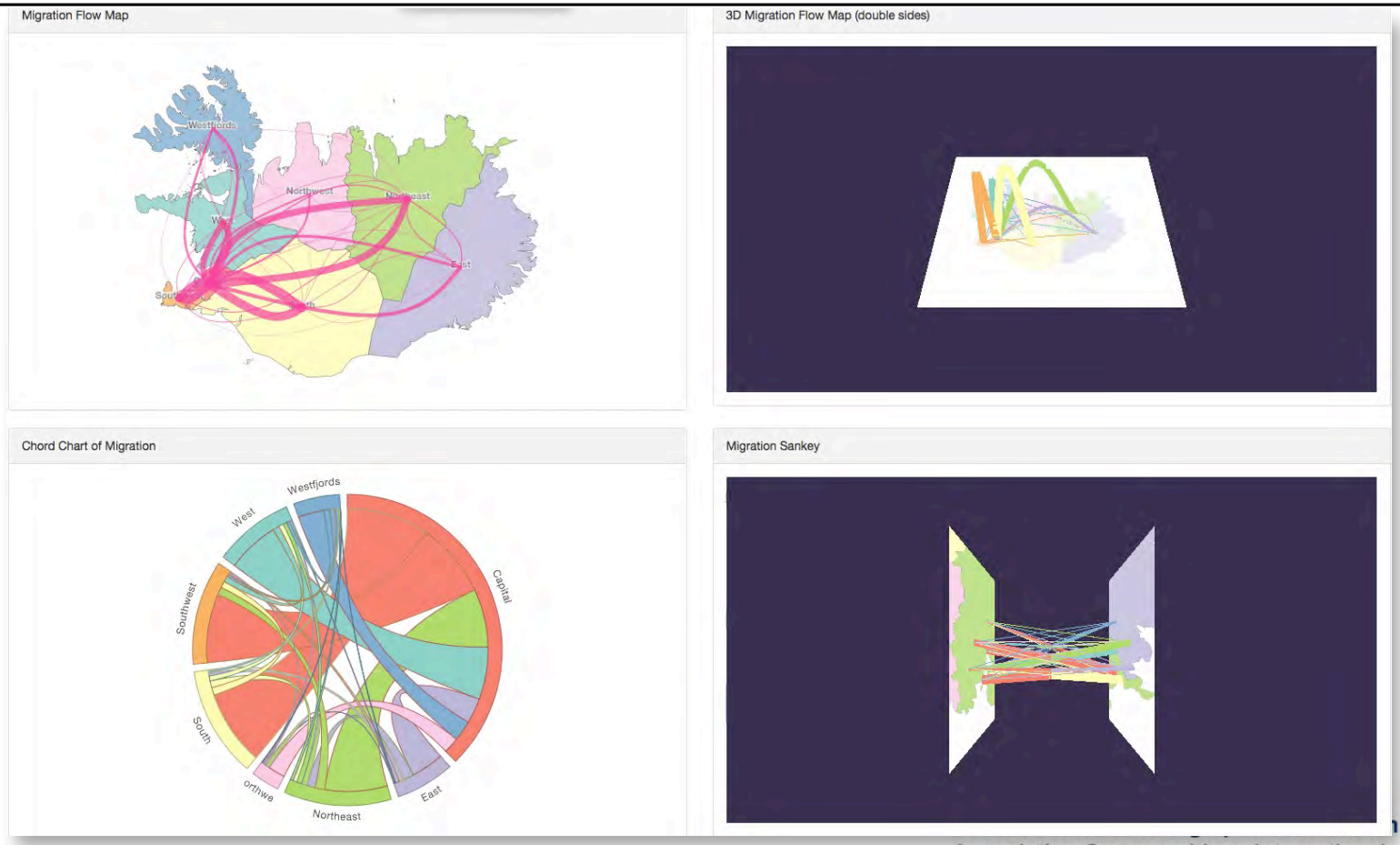
3D map



3D Sankey



Dashboard approach



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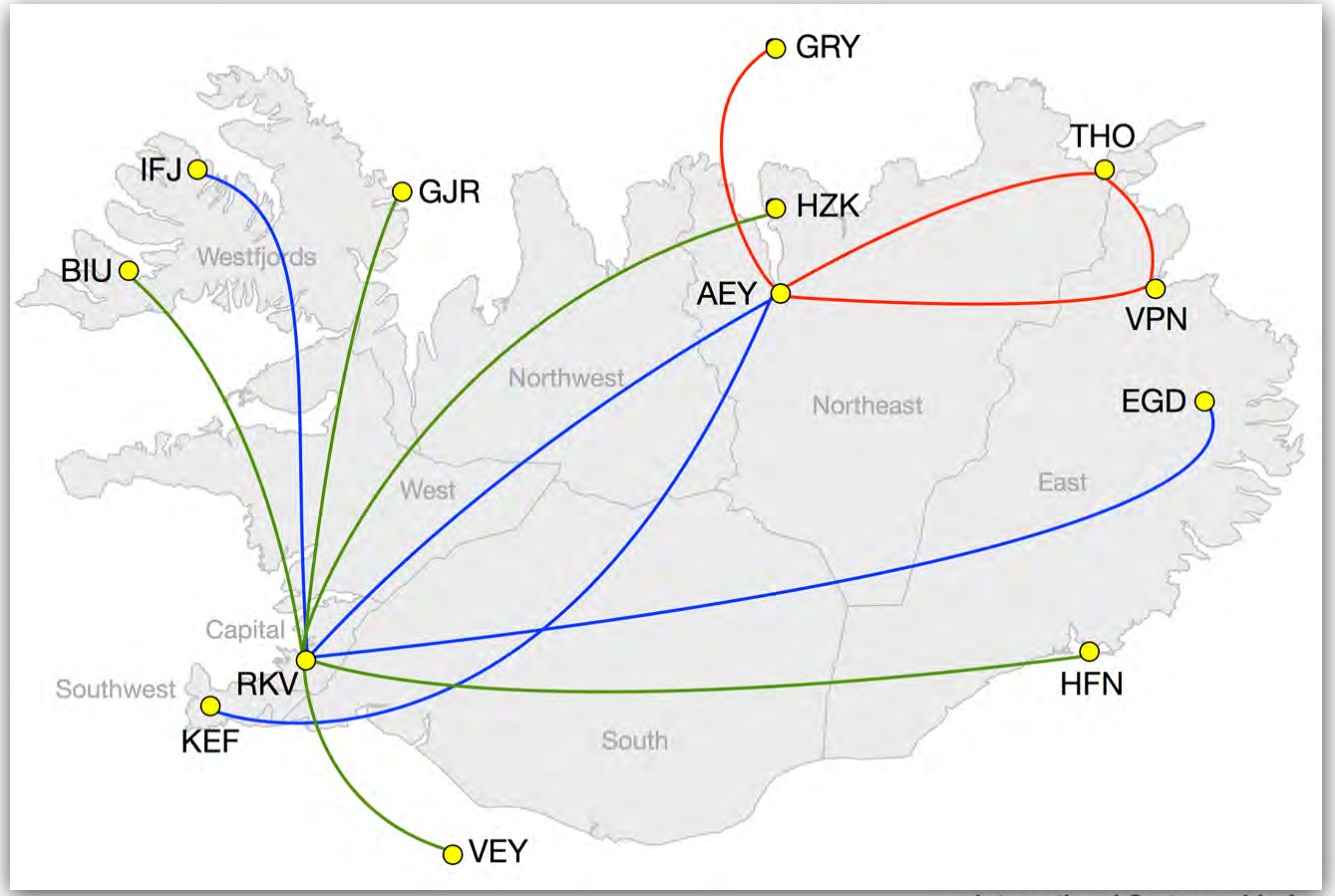
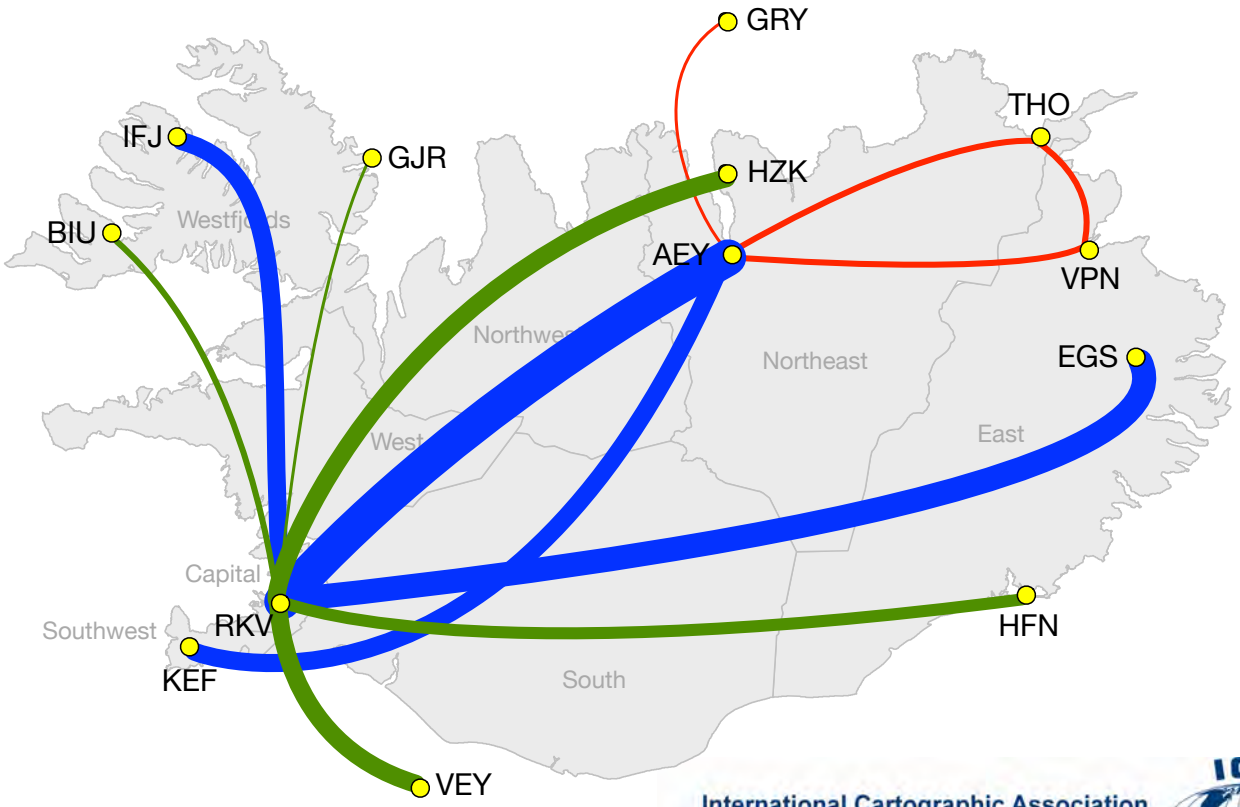
Temporal granularity and A-symmetric O-D matrix



Frequency of connections

	AEY	BIU	EGS	GJR	GRY	HFN	HZK	IFJ	KEF	RKV	THO	VEJ	VPN
AEY					3				13	33	0		5
BIU										6			
EGS										22			
GJR										2			
GRY	3												
HFN										9			
HZK										12			
IFJ										13			
KEF	13												
RKV	33	6	22	2		9	12	13				12	
THO	5												0
VEJ										12			
VPN	0										5		



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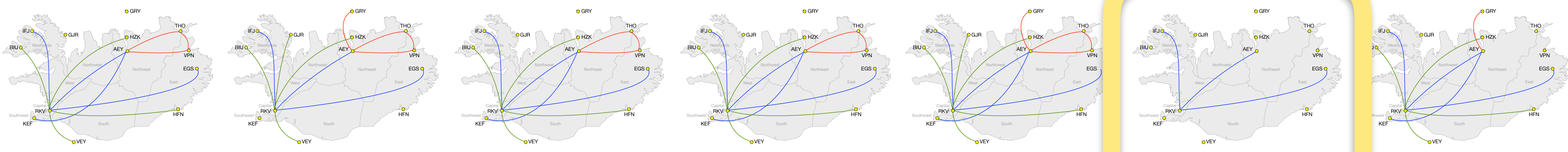
Temporal granularity

	AEY M	AEY T	AEY W	AEY T	AEY F	AEY S	AEY S	BIU M	BIU T	BIU W	BIU T	BIU F	BIU S	BIU S	EGS M	EGS T	EGS W	EGS T	EGS F	EGS S	EGS S	GJR M	GJR T	GJR W	GJR T	GJR F	GJR S	GJR S
AEY																												
BIU																												
EGS																												
GJR																												
GRY	0	1	0	0	1	0	1																					
HFN																												
HZK																												
IFJ																												
KEF	2	0	1	4	2	0	4																					
RKV	5	5	5	5	5	3	5	1	1	1	1	1	0	1	3	3	3	3	3	2	3	0	1	0	0	1	0	0
THO	1	1	1	1	1	0	0																					
VEJ																												
VPN	0	0	0	0	0	0	0																					

	GRY M	GRY T	GRY W	GRY T	GRY F	GRY S	GRY S	HFN M	HFN T	HFN W	HFN T	HFN F	HFN S	HFN S	HZK M	HZK T	HZK W	HZK T	HZK F	HZK S	HZK S
AEY	0	1	0	0	1	0	1														
BIU																					
EGS																					
GJR																					
GRY																					
HFN																					
HZK																					
IFJ																					
KEF																					
RKV								2	0	2	2	2	0	1	2	2	2	2	2	0	2
THO																					
VEJ																					
VPN																					

	IFJ M	IFJ T	IFJ W	IFJ T	IFJ F	IFJ S	IFJ S	KEF M	KEF T	KEF W	KEF T	KEF F	KEF S	KEF S	RKV M	RKV T	RKV W	RKV T	RKV F	RKV S	RKV S
AEY								2	0	1	4	2	0	4	5	5	5	5	5	3	5
BIU															1	1	1	1	1	0	1
EGS															3	3	3	3	3	2	3
GJR															0	1	0	0	1	0	0
GRY																					
HFN															2	0	2	2	2	0	1
HZK															2	2	2	2	2	0	2
IFJ															2	2	2	2	2	1	2
KEF																					
RKV	2	2	2	2	2	1	2														
THO																					
VEJ															2	2	2	2	2	0	2
VPN																					

	THO M	THO T	THO W	THO T	THO F	THO S	THO S	VEJ M	VEJ T	VEJ W	VEJ T	VEJ F	VEJ S	VEJ S	VPN M	VPN T	VPN W	VPN T	VPN F	VPN S	VPN S
AEY	0	0	0	0	0	0	0								1	1	1	1	1	0	0
BIU																					
EGS																					
GJR																					
GRY																					
HFN																					
HZK																					
IFJ																					
KEF																					
RKV								2	2	2	2	2	0	2							
THO															0	0	0	0	0	0	0
VEJ																					
VPN	1	1	1	1	1	0	0														



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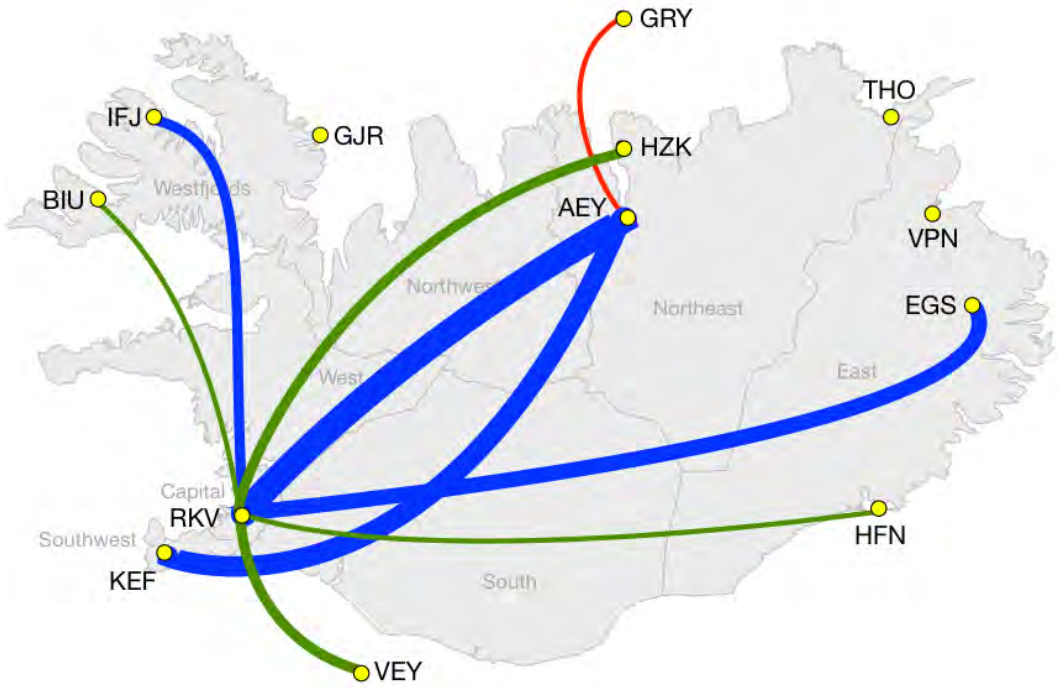
Flying a week in Iceland



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ICA
ACI

	AEY	BIU	EGS	GJR	GRY	HFN	HZK	IFJ	KEF	RKV	THO	VEJ	VPN
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GJR										0 1 0 0 1 0 0			
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IFJ										2 2 2 2 2 1 2			
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VEJ										2 2 2 2 2 0 2			
VPN	0 0 0 0 0 0 0										1 1 1 1 1 0 0		

RKV >	HFN						
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HFN >	RKV						
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18:00	:45 (19:45)		:45 (19:45)	:45 (19:45)	:45 (19:45)		
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From Reykjavik to Höfn

RKV >	HFN						
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17:00	: 30 (18:25)		:30 (18:25)	:30 (18:25)	:30 (18:25)		
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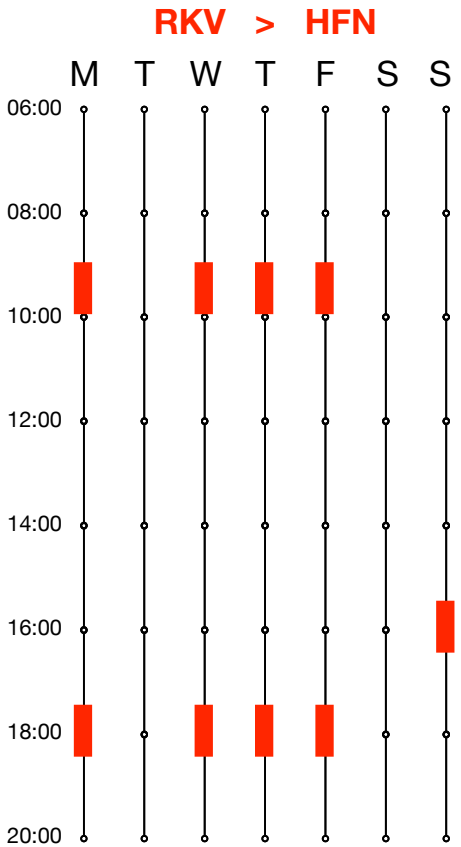

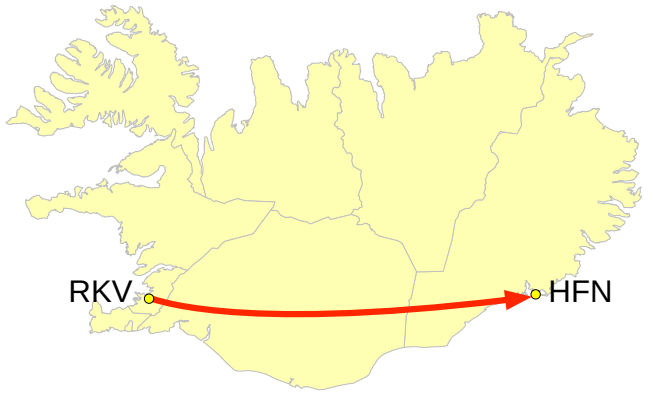

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From Höfn to Reykjavik

HFN >	RKV						
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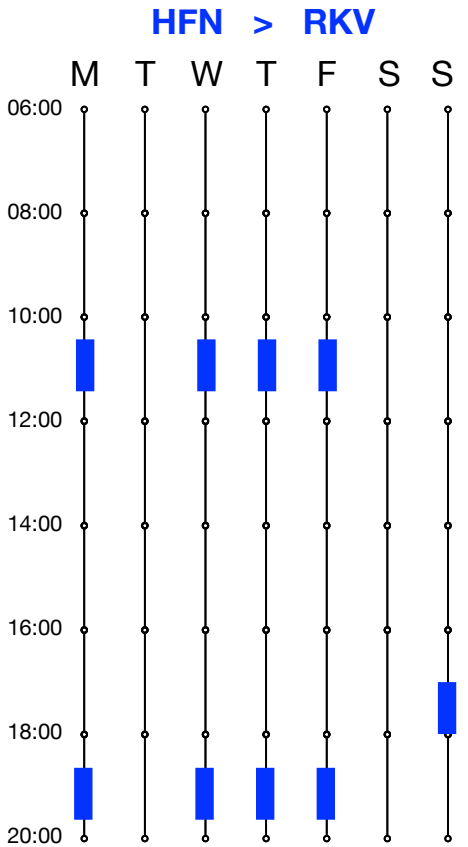

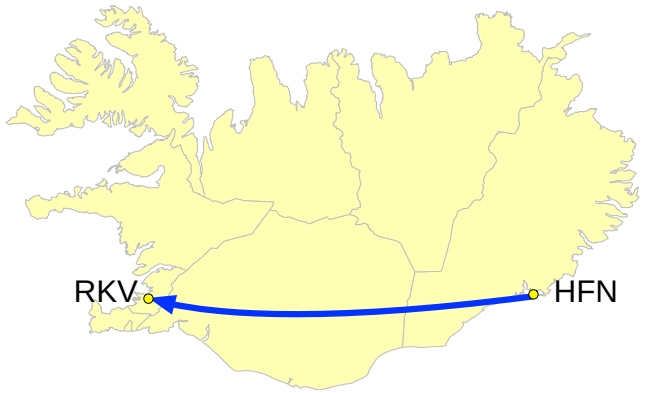

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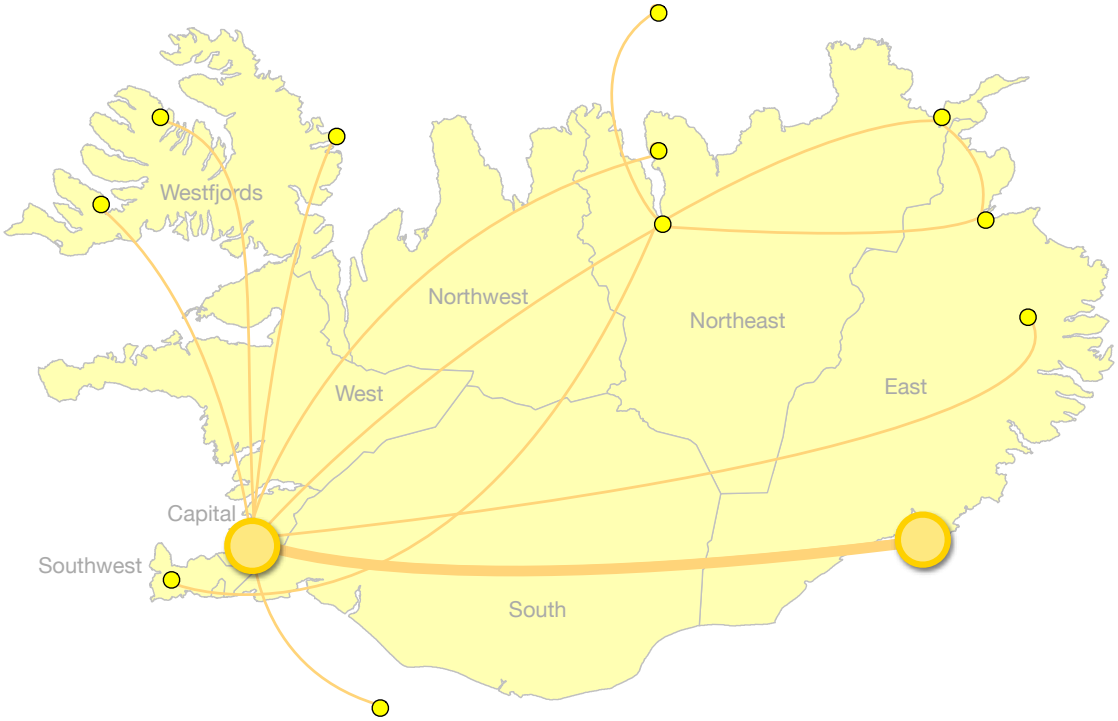

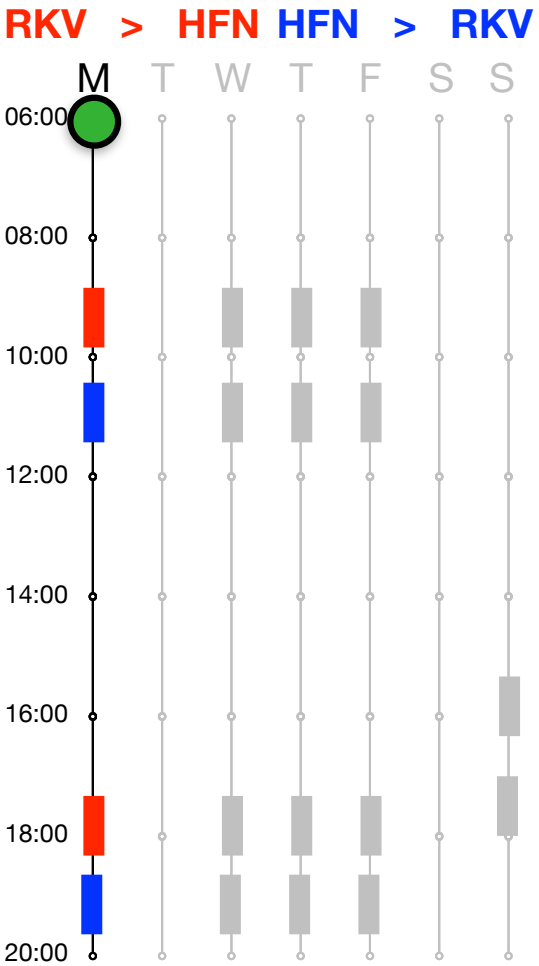

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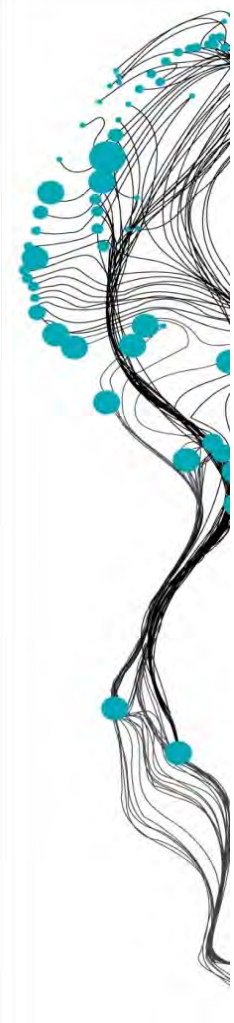

Conclusions

- Multi-dimensional visualization of O-D data does provide alternative insights in movement data
- Challenges:
  - OD Time series
  - Temporal granularity with OD matrix
  - Geocomputational efforts before the visualizations
  - Usability efforts after the visualizations

Let’s make the world a better place with maps