

SAISIS UNAM

Earth sciences and humanities – Mexico City

Network science to analyse insecurity perturbations that undermine Mexican tourism industry





WHY TOURISM MATTERS



Tourism is more than you imagine!

Source: World Tourism Organization (UNWTO) ©
* Source: World Travel & Tourism Council (WTTC)

Introduction



Por Ingreso de Divisas (miles de millones de dólares)					Por Llegada de Turistas (millones de turistas)				
Clasificación		País	Año		Clasificación		País	Año	
2017	2018		2017	2018	2017	2018		2017	2018
1	1	Estados Unidos	210.7	214.5	1	1	Francia	86.9	n.d
2	2	España	68.1	73.8	2	2	España	81.9	82.8
3	3	Francia	60.7	67.4	3	3	Estados Unidos	76.9	ND
4	4	Tailandia	56.9	63.0	4	4	China	60.7	62.9
5	5	Reino Unido	49.0	51.9	5	5	Italia	58.3	62.1
6	6	Italia	44.2	49.3	8	6	Turquía	37.6	45.8
7	7	Australia	41.7	45.0	6	7	México	39.3	41.4
8	8	Alemania	39.8	43.0	9	8	Alemania	37.5	38.9
11	9	Japón	34.1	41.1	10	9	Tailandia	35.5	38.3
9	10	China	38.6	40.4	7	10	Reino Unido	37.7	ND
10	11	Macao (China)	35.6	40.2	12	11	Japón	28.7	31.2
12	12	Hong Kong (China)	33.3	36.7	11	12	Austria	29.5	30.8
13	13	India	27.4	28.6	14	13	Grecia	27.2	30.1
14	14	Turquía	22.5	25.2	13	14	Hong Kong (China)	27.9	29.3
17	15	Austria	20.4	23.0	15	15	Malasia	25.9	25.8
15	16	México	21.3	22.5	16	16	Rusia	24.4	24.6
18	17	Canadá	20.3	21.9	17	17	Portugal	21.2	ND
16	18	Emiratos Arabes Unidos	21.0	21.4	18	18	Canadá	20.9	21.1
Total mundial			1,448		Total mundial			1,403	



Data Sources

Availability of data

Datur

- Mexican tourist destinations
- Occupancy rates



Overseas Security Advisory Council (OSAC)

- Travel advisories





Research design

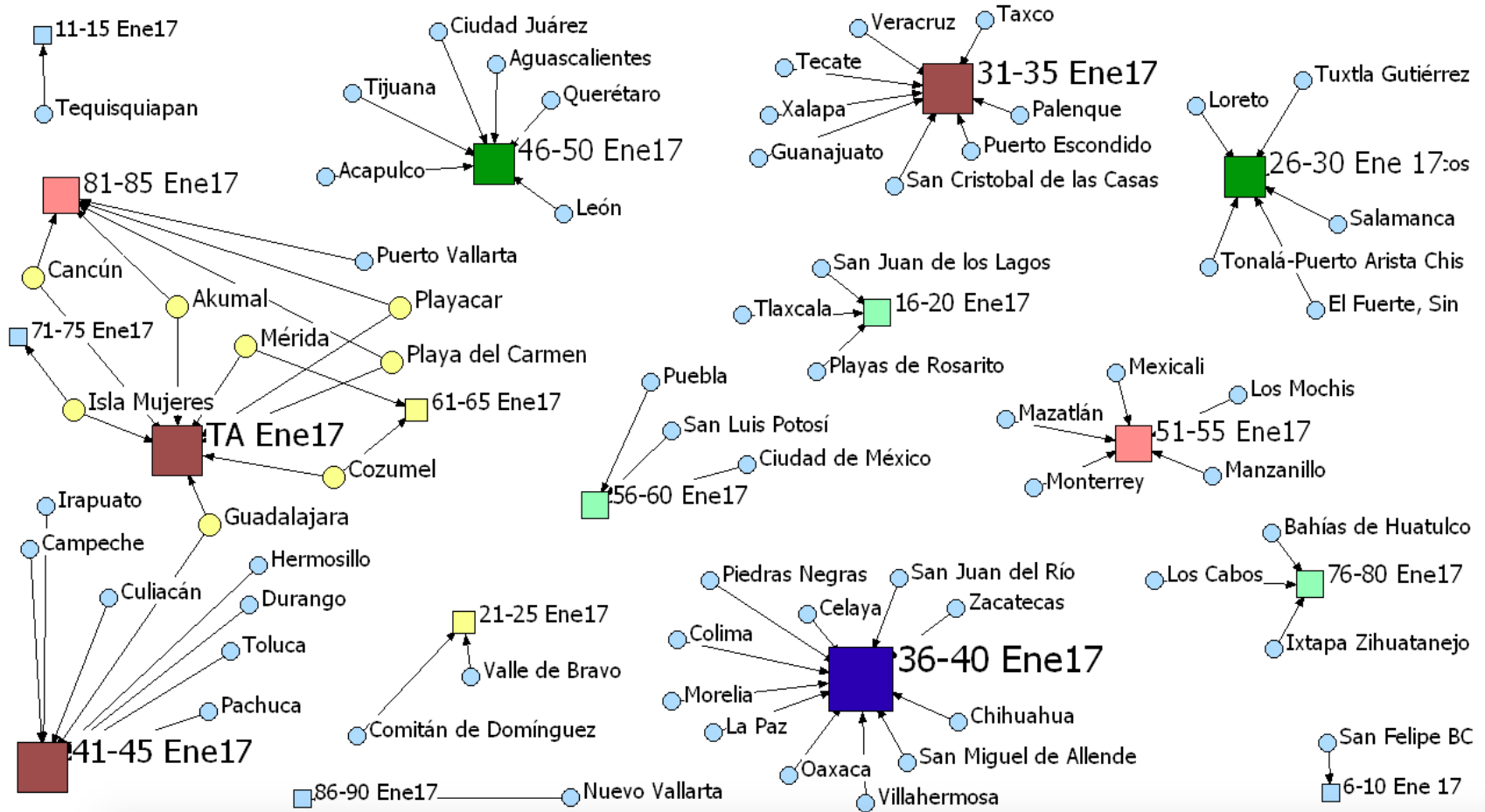
- Tripartite. Destinations-Rates-Advisories networks
- Tourism mobility as complex system susceptible to external perturbations



Findings



January 2017





January 2017

42	Culiacn	0.048	0.006	0.071	2.254	0.000
43	Salamanca	0.048	0.004	0.000	13.727	0.000
44	Palenque	0.048	0.006	0.000	10.067	0.000
45	Celaya	0.048	0.008	0.000	7.190	0.000
46	Durango	0.048	0.006	0.071	2.254	0.000
47	Pachuca	0.048	0.006	0.071	2.254	0.000
48	Irapuato	0.048	0.006	0.071	2.254	0.000
49	San Miguel de Allende	0.048	0.008	0.000	7.190	0.000
50	Coahuila	0.048	0.004	0.000	13.727	0.000
51	Campeche	0.048	0.006	0.071	2.254	0.000
52	Los Mochis	0.048	0.004	0.000	16.778	0.000
53	Colima	0.048	0.008	0.000	7.190	0.000
54	San Juan del Ro	0.048	0.008	0.000	7.190	0.000
55	Taxco	0.048	0.006	0.000	10.067	0.000
56	Valle de Bravo	0.048	0.001	0.000	50.333	0.000
57	Tequisquiapan	0.048	0.001	0.000	151.000	0.000
58	Comitn de Domnguez	0.048	0.001	0.000	50.333	0.000
59	Ciudad Jurez	0.048	0.004	0.000	13.727	0.000
60	Mexicali	0.048	0.004	0.000	16.778	0.000
61	Piedras Negras	0.048	0.008	0.000	7.190	0.000
62	Tecate	0.048	0.006	0.000	10.067	0.000
63	Tijuana	0.048	0.004	0.000	13.727	0.000
64	Akumal	0.095	0.009	0.390	2.745	0.002
65	Playa del Carmen	0.095	0.009	0.390	2.745	0.002
66	Playacar	0.095	0.009	0.390	2.745	0.002

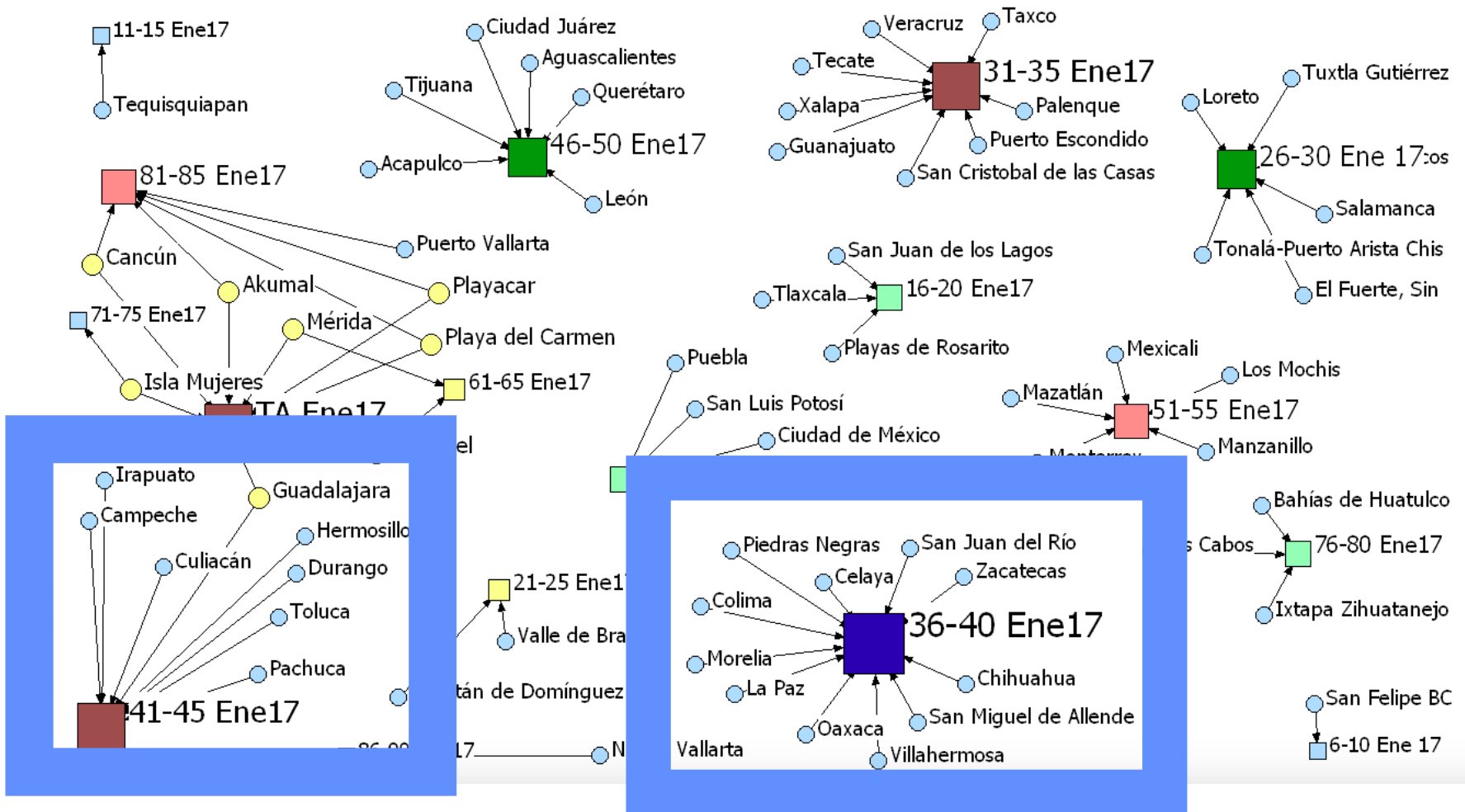
2-Mode Centrality Measures for COLUMNS of DRA Enero 17

	1	2	3	4	5
	Degree	2-Local	Eigenvect	Closeness	Betweenne
1	0-5 Ene17	0.000	0.000	0.000	0.000
2	6-10 Ene 17	0.015	0.000	0.000	106.000
3	11-15 Ene17	0.015	0.000	0.000	106.000
4	16-20 Ene17	0.045	0.002	0.000	35.333
5	21-25 Ene17	0.030	0.001	0.000	53.000
6	26-30 Ene 17	0.091	0.008	0.000	17.667
7	31-35 Ene17	0.121	0.015	0.000	13.250
8	36-40 Ene17	0.167	0.028	0.000	9.636
9	41-45 Ene17	0.121	0.015	0.241	2.208
10	46-50 Ene17	0.091	0.008	0.000	17.667
11	51-55 Ene17	0.076	0.006	0.000	21.200
12	56-60 Ene17	0.045	0.002	0.000	35.333
13	61-65 Ene17	0.030	0.001	0.172	1.432
14	66-70 Ene17	0.000	0.000	0.000	0.000
15	71-75 Ene17	0.015	0.000	0.078	1.395
16	76-80 Ene17	0.045	0.002	0.000	35.333
17	81-85 Ene17	0.076	0.006	0.508	1.606
18	86-90 Ene17	0.015	0.000	0.000	106.000
19	91-95 Ene17	0.000	0.000	0.000	0.000
20	96-100 Ene17	0.000	0.000	0.000	0.000
21	TA Ene17	0.121	0.015	0.805	2.650

Findings



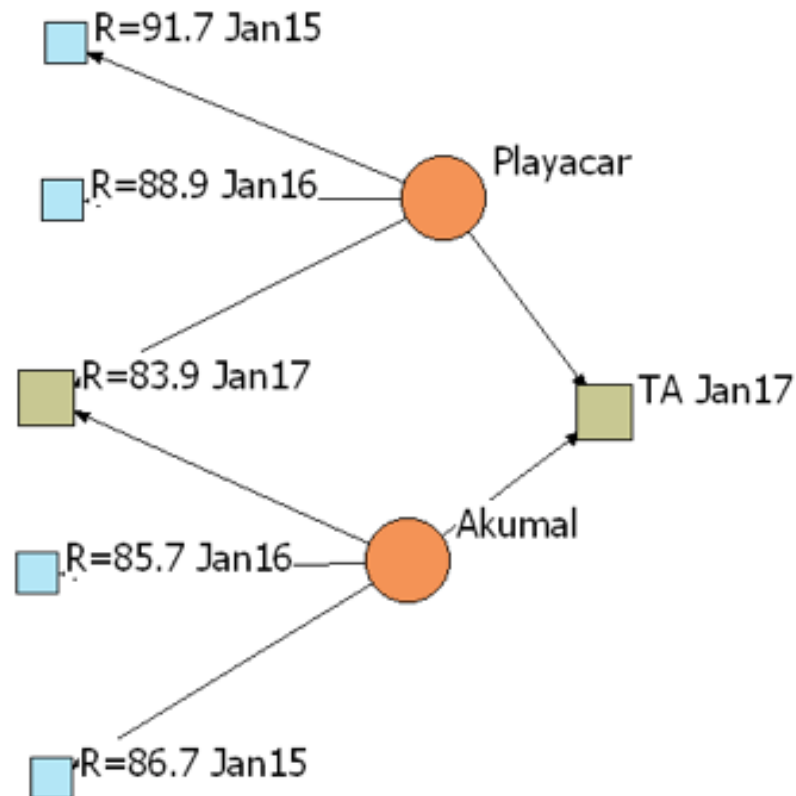
January 2017





Findings

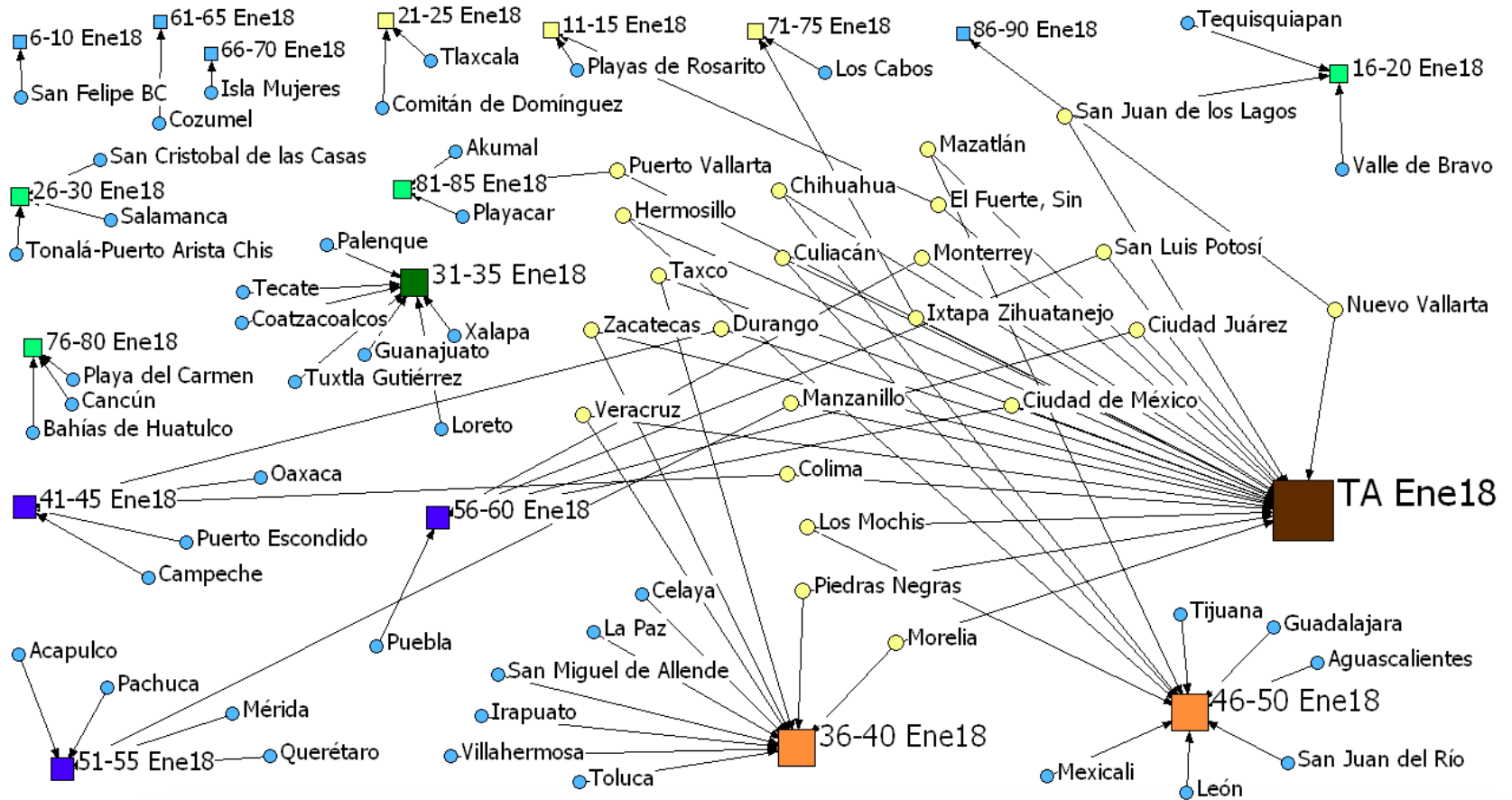
- Two destinations where occupation rates decreased compared to previous years



Findings



January 2018





42	Culiacn	0.095	0.024	0.229	0.926	0.019
43	Salamanca	0.048	0.002	0.000	30.200	0.000
44	Palenque	0.048	0.005	0.000	11.615	0.000
45	Celaya	0.048	0.008	0.056	0.588	0.000
46	Durango	0.095	0.019	0.189	0.893	0.030
47	Pachuca	0.048	0.004	0.008	0.553	0.000
48	Irapuato	0.048	0.008	0.056	0.588	0.000
49	San Miguel de Allende	0.048	0.008	0.056	0.588	0.000
50	Coatzacoalcos	0.048	0.005	0.000	11.615	0.000
51	Campeche	0.048	0.004	0.016	0.549	0.000
52	Los Mochis	0.095	0.024	0.229	0.926	0.019
53	Colima	0.095	0.019	0.189	0.893	0.030
54	San Juan del Ro	0.048	0.008	0.056	0.588	0.000
55	Taxco	0.095	0.024	0.229	0.926	0.019
56	Valle de Bravo	0.048	0.002	0.007	0.537	0.000
57	Tequisquiapan	0.048	0.002	0.007	0.537	0.000
58	Comitn de Domnguez	0.048	0.001	0.000	50.333	0.000
59	Ciudad Jurez	0.095	0.019	0.205	0.873	0.008
60	Mexicali	0.048	0.008	0.056	0.588	0.000
61	Piedras Negras	0.095	0.024	0.229	0.926	0.019
62	Tecate	0.048	0.005	0.000	11.615	0.000
63	Tijuana	0.048	0.008	0.056	0.588	0.000
64	Akumal	0.048	0.002	0.007	0.537	0.000
65	Playa del Carmen	0.048	0.002	0.000	30.200	0.000
66	Playacar	0.048	0.002	0.007	0.537	0.000

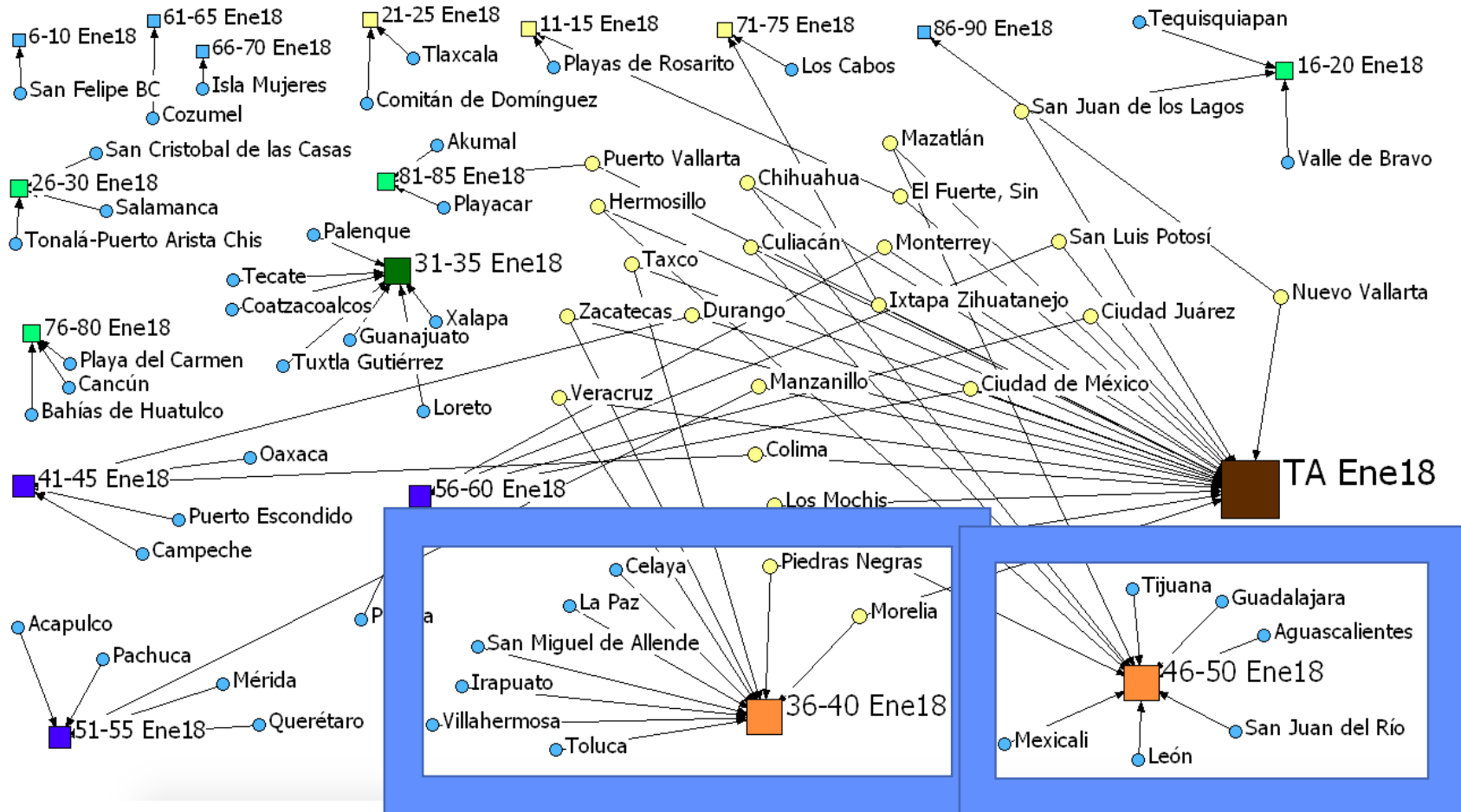
2-Mode Centrality Measures for COLUMNS of DRA Ene 18

	1	2	3	4	5	
	Degree	2-Local	Eigenvect	Closeness	Betweenne	
1	0-5 Ene18	0.000	0.000	0.000	0.000	0.000
2	6-10 Ene18	0.015	0.000	0.000	106.000	0.000
3	11-15 Ene18	0.030	0.001	0.036	0.465	0.016
4	16-20 Ene18	0.045	0.002	0.038	0.473	0.031
5	21-25 Ene18	0.030	0.001	0.000	53.000	0.000
6	26-30 Ene18	0.045	0.002	0.000	35.333	0.001
7	31-35 Ene18	0.106	0.011	0.000	15.143	0.006
8	36-40 Ene18	0.167	0.028	0.288	0.530	0.091
9	41-45 Ene18	0.076	0.006	0.083	0.486	0.046
10	46-50 Ene18	0.167	0.028	0.288	0.530	0.091
11	51-55 Ene18	0.076	0.006	0.042	0.491	0.061
12	56-60 Ene18	0.076	0.006	0.166	0.477	0.017
13	61-65 Ene18	0.015	0.000	0.000	106.000	0.000
14	66-70 Ene18	0.015	0.000	0.000	106.000	0.000
15	71-75 Ene18	0.030	0.001	0.036	0.465	0.016
16	76-80 Ene18	0.045	0.002	0.000	35.333	0.001
17	81-85 Ene18	0.045	0.002	0.038	0.473	0.031
18	86-90 Ene18	0.015	0.000	0.035	0.457	0.000
19	91-95 Ene18	0.000	0.000	0.000	0.000	0.000
20	96-100 Ene18	0.000	0.000	0.000	0.000	0.000
21	TA Ene18	0.333	0.111	0.889	0.883	0.405

Findings



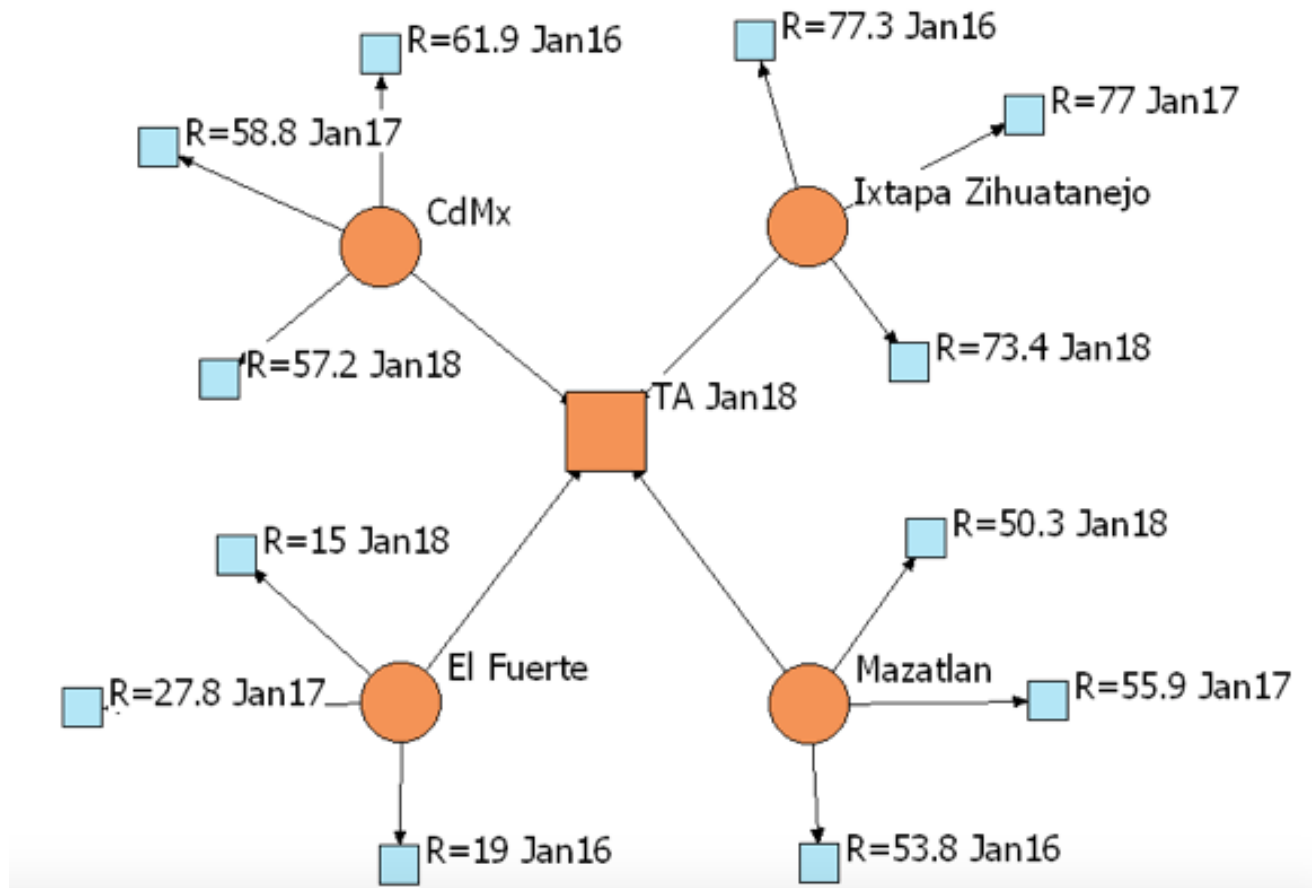
January 2018





Findings

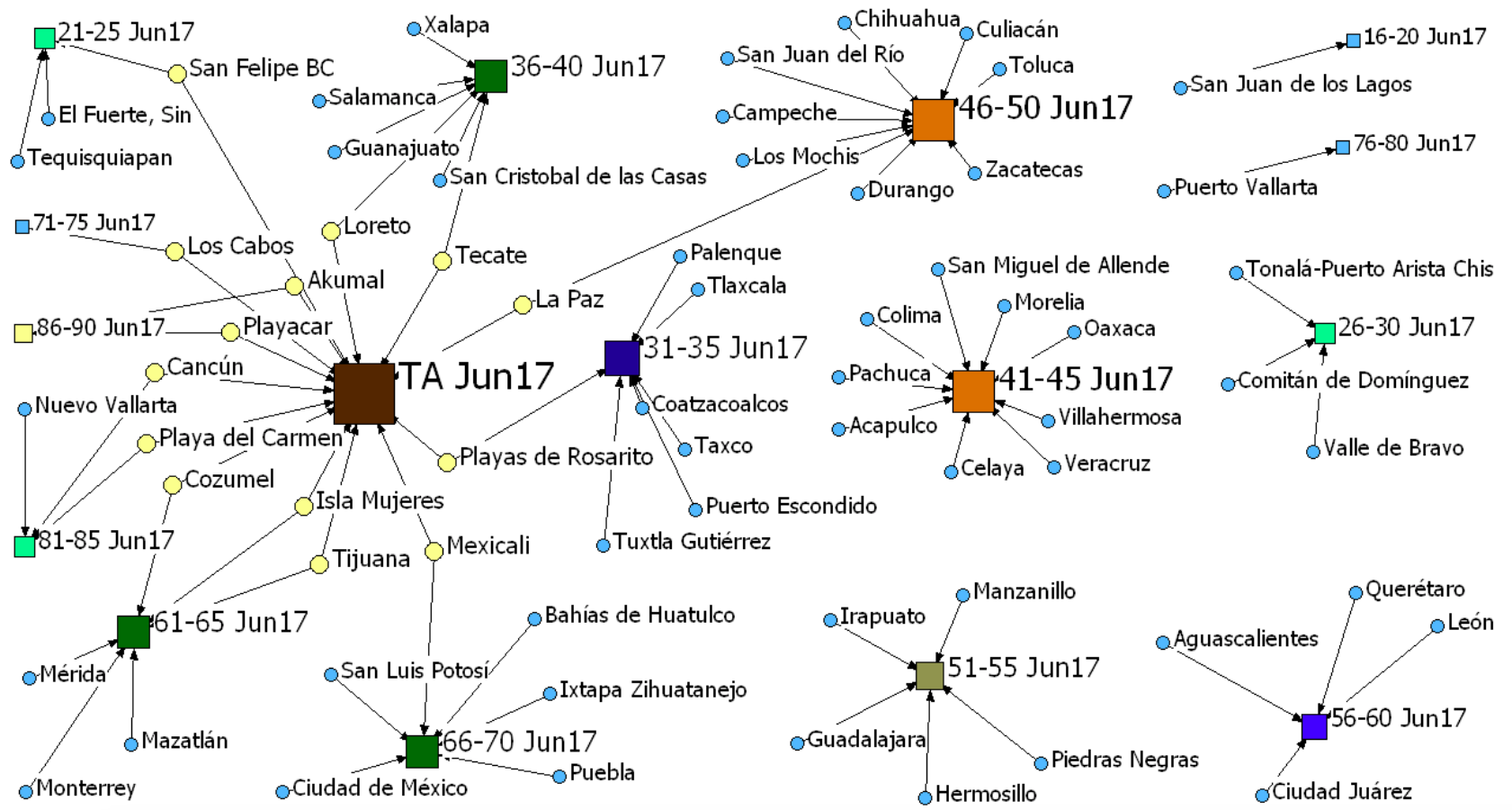
- Four destinations where occupation rates decreased compared to previous years



Findings



June 2017



Findings



June 2017

42	Culiacan	0.048	0.006	0.031	0.634	0.000
43	Salamanca	0.048	0.004	0.044	0.599	0.000
44	Palenque	0.048	0.005	0.024	0.614	0.000
45	Celaya	0.048	0.006	0.000	8.882	0.000
46	Durango	0.048	0.006	0.031	0.634	0.000
47	Pachuca	0.048	0.006	0.000	8.882	0.000
48	Irapuato	0.048	0.004	0.000	16.778	0.000
49	San Miguel de Allende	0.048	0.006	0.000	8.882	0.000
50	Coatzacoalcos	0.048	0.005	0.024	0.614	0.000
51	Campeche	0.048	0.006	0.031	0.634	0.000
52	Los Mochis	0.048	0.006	0.031	0.634	0.000
53	Colima	0.048	0.006	0.000	8.882	0.000
54	San Juan del Ro	0.048	0.006	0.031	0.634	0.000
55	Taxco	0.048	0.005	0.024	0.614	0.000
56	Valle de Bravo	0.048	0.002	0.000	30.200	0.000
57	Tequisquiapan	0.048	0.002	0.017	0.576	0.000
58	Comitn de Domnguez	0.048	0.002	0.000	30.200	0.000
59	Ciudad Jurez	0.048	0.003	0.000	21.571	0.000
60	Mexicali	0.095	0.014	0.246	0.956	0.078
61	Piedras Negras	0.048	0.004	0.000	16.778	0.000
62	Tecate	0.095	0.014	0.268	0.944	0.033
63	Tijuana	0.095	0.014	0.290	0.932	0.017
64	Akumal	0.095	0.012	0.256	0.899	0.007
65	Playa del Carmen	0.095	0.012	0.258	0.910	0.014
66	Playacar	0.095	0.012	0.256	0.899	0.007

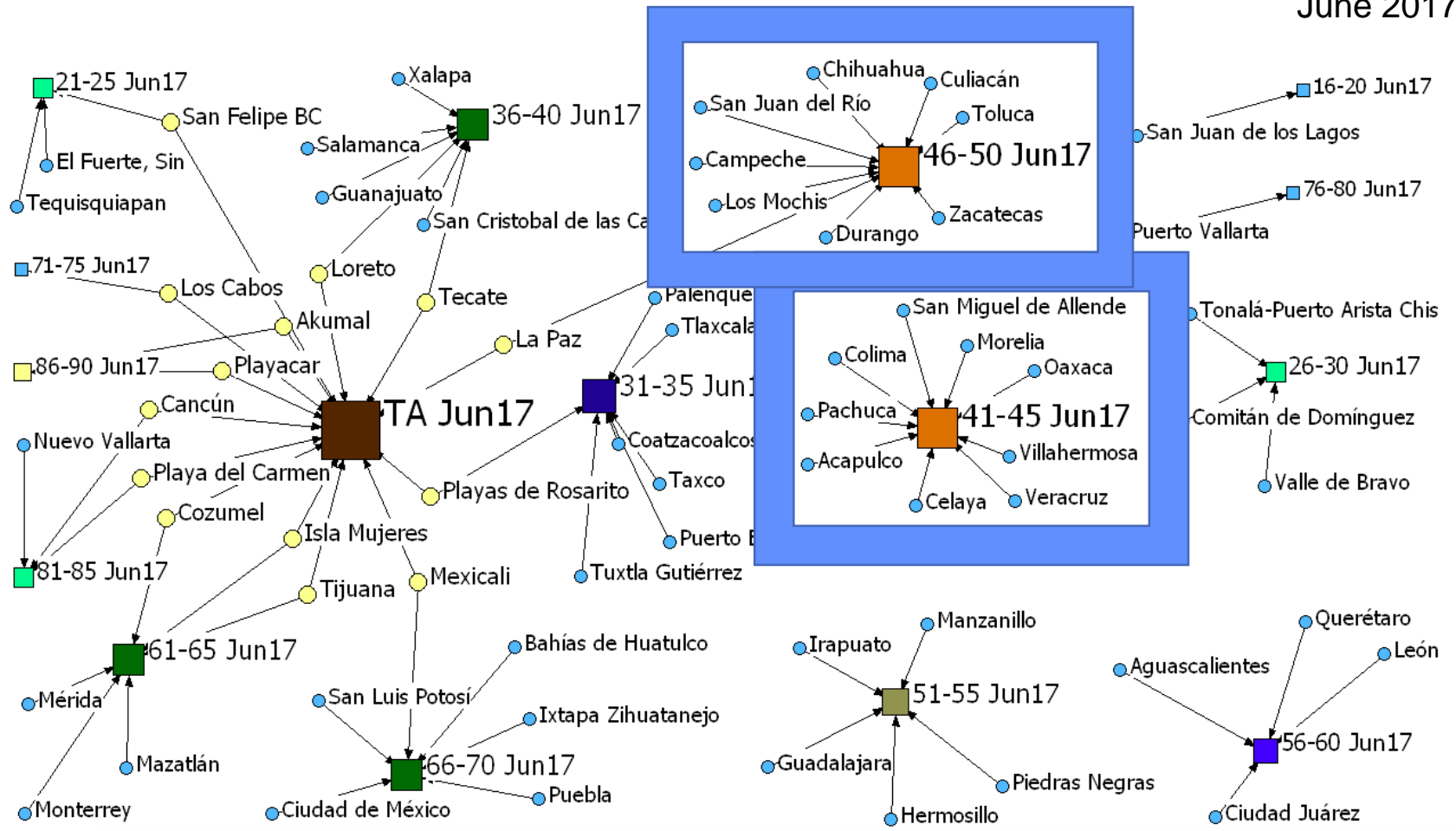
2-Mode Centrality Measures for COLUMNS of DRA Jun 17

	1	2	3	4	5	
	Degree	2-Local	Eigenvect	Closeness	Betweenne	
1	0-5 Jun17	0.000	0.000	0.000	0.000	0.000
2	6-10 Jun17	0.000	0.000	0.000	0.000	0.000
3	11-15 Jun17	0.000	0.000	0.000	0.000	0.000
4	16-20 Jun17	0.015	0.000	0.000	106.000	0.000
5	21-25 Jun17	0.045	0.002	0.068	0.502	0.028
6	26-30 Jun17	0.045	0.002	0.000	35.333	0.001
7	31-35 Jun17	0.106	0.011	0.097	0.544	0.080
8	36-40 Jun17	0.091	0.008	0.176	0.527	0.055
9	41-45 Jun17	0.136	0.019	0.000	11.778	0.010
10	46-50 Jun17	0.136	0.019	0.124	0.567	0.105
11	51-55 Jun17	0.078	0.006	0.000	21.200	0.003
12	56-60 Jun17	0.061	0.004	0.000	26.500	0.002
13	61-65 Jun17	0.091	0.008	0.264	0.522	0.042
14	66-70 Jun17	0.091	0.008	0.088	0.533	0.067
15	71-75 Jun17	0.015	0.000	0.059	0.484	0.000
16	76-80 Jun17	0.015	0.000	0.000	106.000	0.000
17	81-85 Jun17	0.045	0.002	0.136	0.498	0.014
18	86-90 Jun17	0.030	0.001	0.127	0.488	0.000
19	91-95 Jun17	0.000	0.000	0.000	0.000	0.000
20	96-100 Jun17	0.000	0.000	0.000	0.000	0.000
21	TA Jun17	0.212	0.045	0.908	0.891	0.324

Findings



June 2017



Findings



- None destination affected





42	Culiacn	0.045	0.006	0.000	10.133	0.000
43	Salamanca	0.045	0.003	0.042	0.749	0.000
44	Palenque	0.091	0.012	0.311	1.160	0.007
45	Celaya	0.045	0.006	0.034	0.822	0.000
46	Durango	0.045	0.005	0.000	11.692	0.000
47	Pachuca	0.045	0.006	0.034	0.822	0.000
48	Irapuato	0.045	0.005	0.000	11.692	0.000
49	San Miguel de Allende	0.045	0.006	0.034	0.822	0.000
50	Coatzacoalcos	0.091	0.012	0.311	1.160	0.007
51	Campeche	0.045	0.006	0.000	10.133	0.000
52	Los Mochis	0.045	0.006	0.000	10.133	0.000
53	Colima	0.045	0.006	0.000	10.133	0.000
54	San Juan del Ro	0.045	0.006	0.000	10.133	0.000
55	Taxco	0.091	0.012	0.311	1.160	0.007
56	Valle de Bravo	0.045	0.002	0.035	0.720	0.000
57	Tequisquiapan	0.045	0.003	0.019	0.741	0.000
58	Comitn de Domnguez	0.091	0.010	0.253	1.143	0.011
59	Ciudad Jurez	0.045	0.003	0.000	21.714	0.000
60	Mexicali	0.045	0.006	0.069	0.813	0.000
61	Piedras Negras	0.045	0.005	0.000	11.692	0.000
62	Tecate	0.045	0.006	0.034	0.822	0.000
63	Tijuana	0.045	0.006	0.069	0.813	0.000
64	Akumal	0.045	0.001	0.000	50.667	0.000
65	Playa del Carmen	0.045	0.002	0.000	30.400	0.000
66	Playacar	0.045	0.001	0.000	50.667	0.000

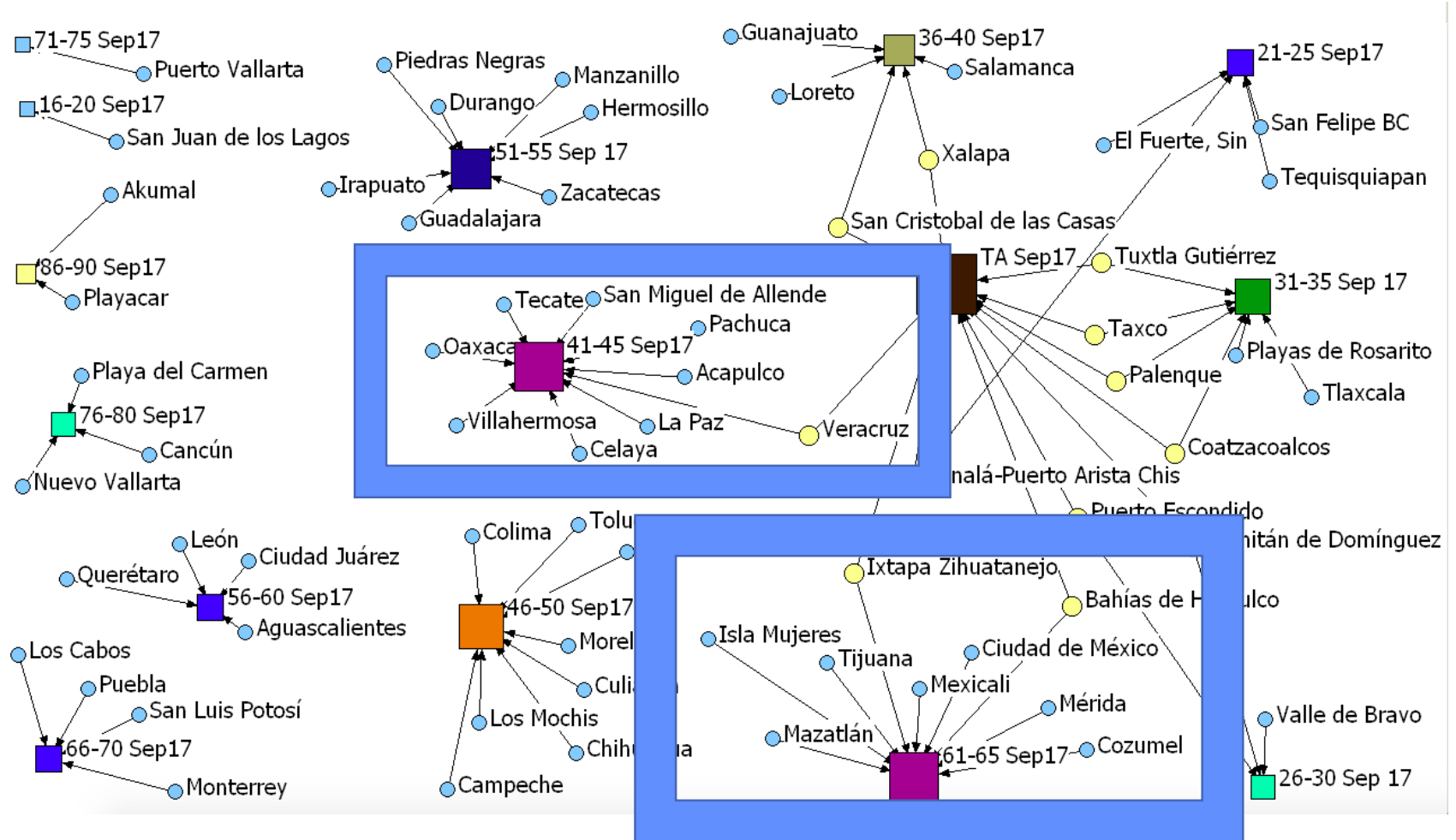
2-Mode Centrality Measures for COLUMNS of DRA Sep 17

	1	2	3	4	5	
	Degree	2-Local	Eigenvect	Closeness	Betweenne	
1	0-5 Sep17	0.000	0.000	0.000	0.000	0.000
2	6-10 Sep17	0.000	0.000	0.000	0.000	0.000
3	11-15 Sep17	0.000	0.000	0.000	0.000	0.000
4	16-20 Sep17	0.015	0.000	0.000	108.000	0.000
5	21-25 Sep17	0.061	0.004	0.075	0.659	0.032
6	26-30 Sep 17	0.045	0.002	0.138	0.635	0.011
7	31-35 Sep 17	0.091	0.008	0.365	0.667	0.023
8	36-40 Sep17	0.076	0.006	0.165	0.667	0.032
9	41-45 Sep17	0.136	0.019	0.135	0.750	0.081
10	46-50 Sep17	0.121	0.015	0.000	13.500	0.008
11	51-55 Sep 17	0.106	0.011	0.000	15.429	0.006
12	56-60 Sep17	0.061	0.004	0.000	27.000	0.002
13	61-65 Sep17	0.136	0.019	0.270	0.740	0.072
14	66-70 Sep17	0.061	0.004	0.000	27.000	0.002
15	71-75 Sep17	0.015	0.000	0.000	108.000	0.000
16	76-80 Sep17	0.045	0.002	0.000	36.000	0.001
17	81-85 Sep17	0.000	0.000	0.000	0.000	0.000
18	86-90 Sep17	0.030	0.001	0.000	54.000	0.000
19	91-95 Sep17	0.000	0.000	0.000	0.000	0.000
20	96-100 Sep17	0.000	0.000	0.000	0.000	0.000
21	96-100 Ene18	0.000	0.000	0.000	0.000	0.000
22	TA Sep17	0.182	0.033	0.851	1.125	0.194

Findings

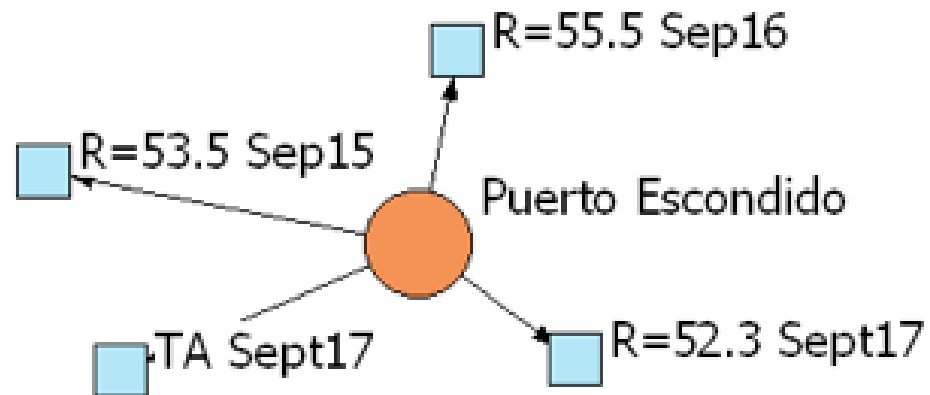


September 2017





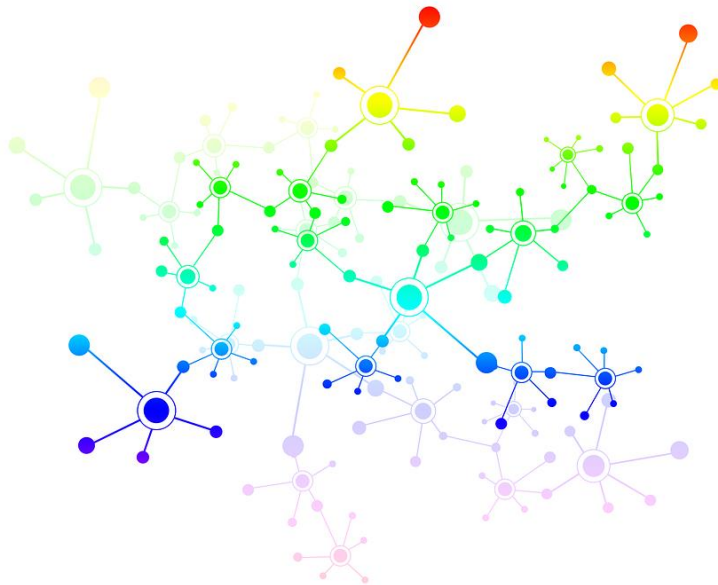
- One destination where occupation rate decreased compared to previous years





Findings

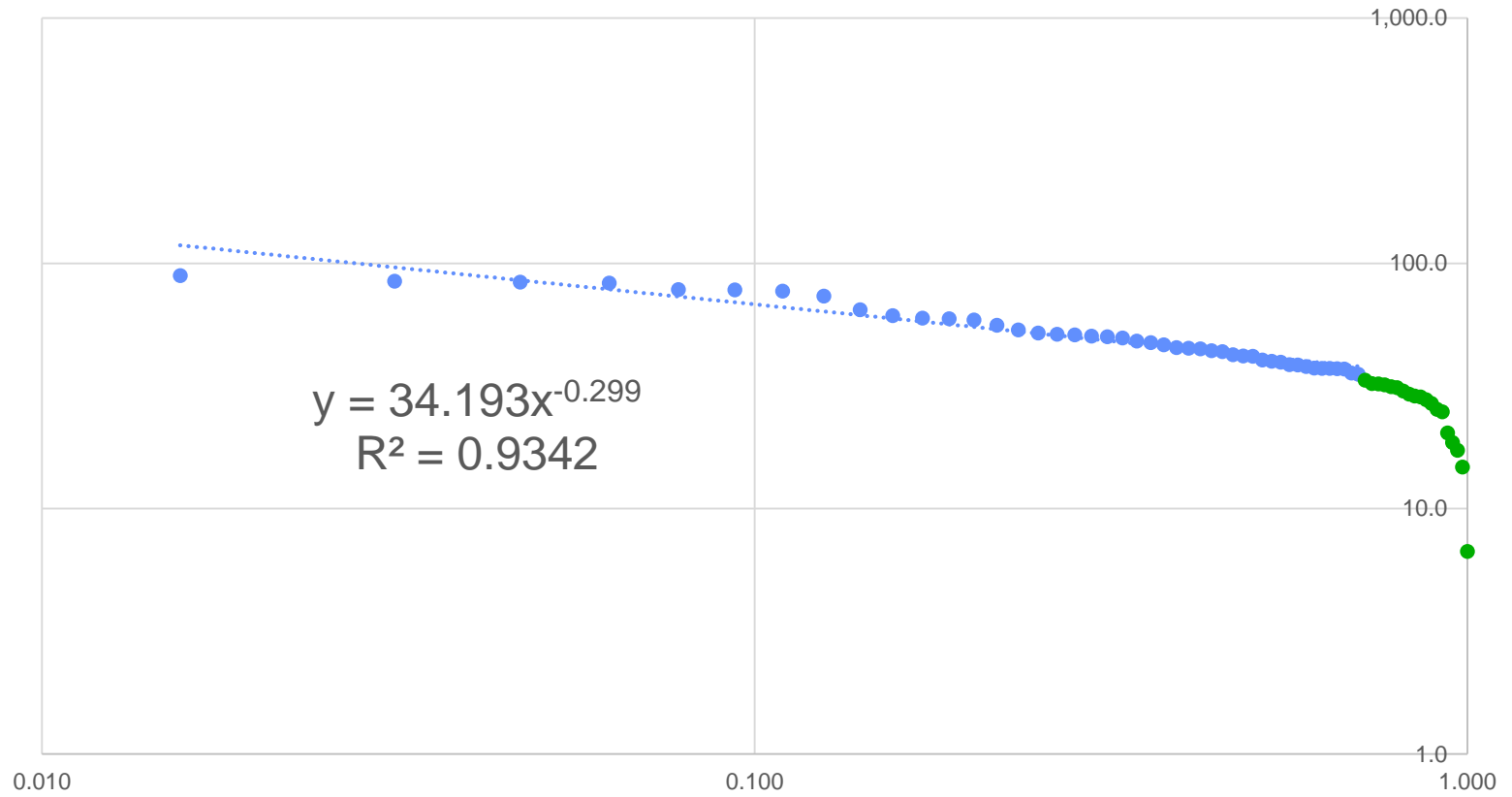
Quantitative characterization of networks

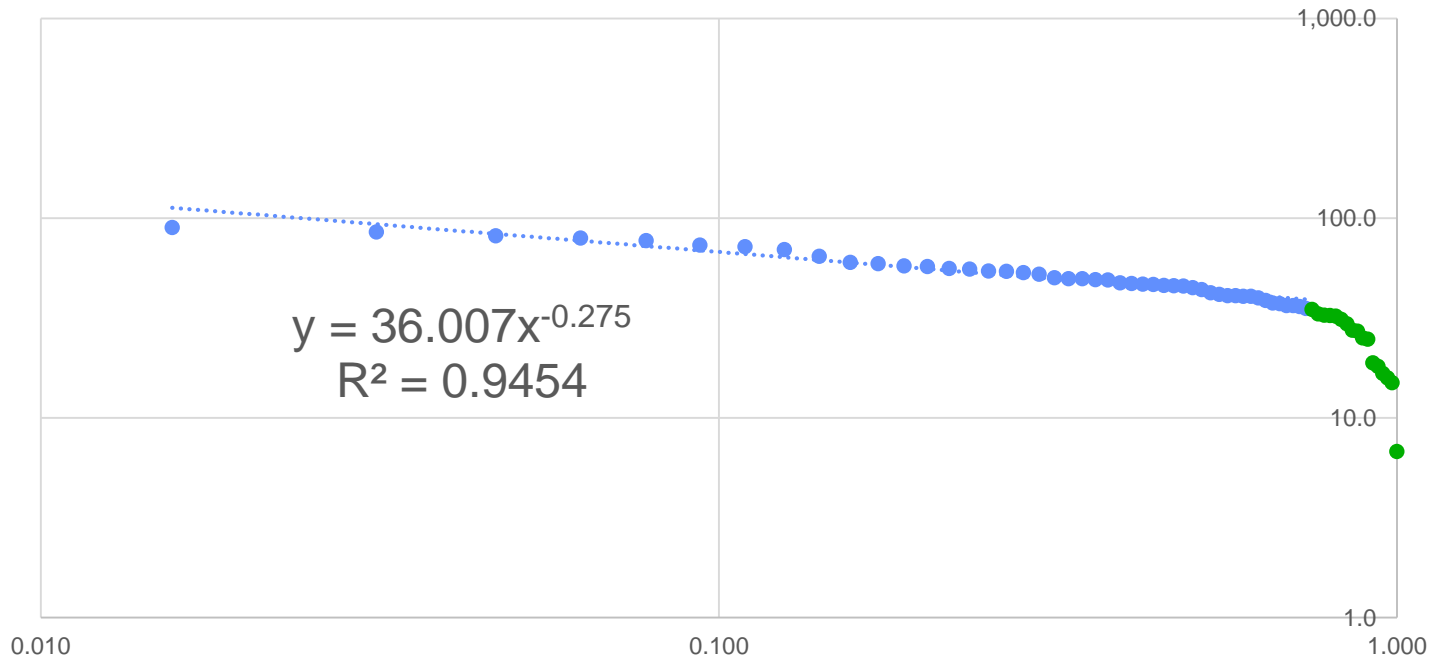


- Occupancy rates distributions
- Better understanding
- Anticipation of tourism mobility encoded dynamic



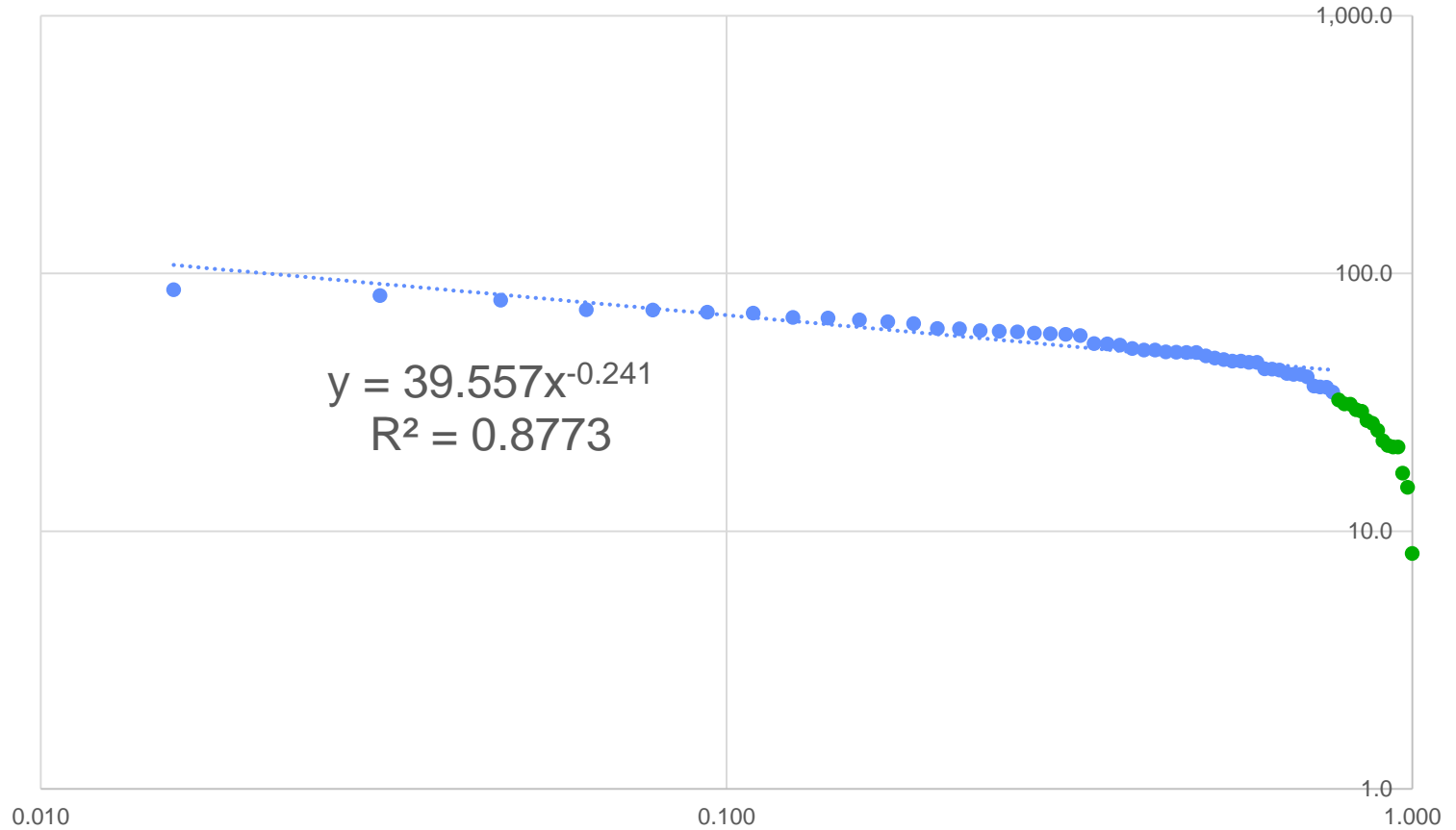
January 2017





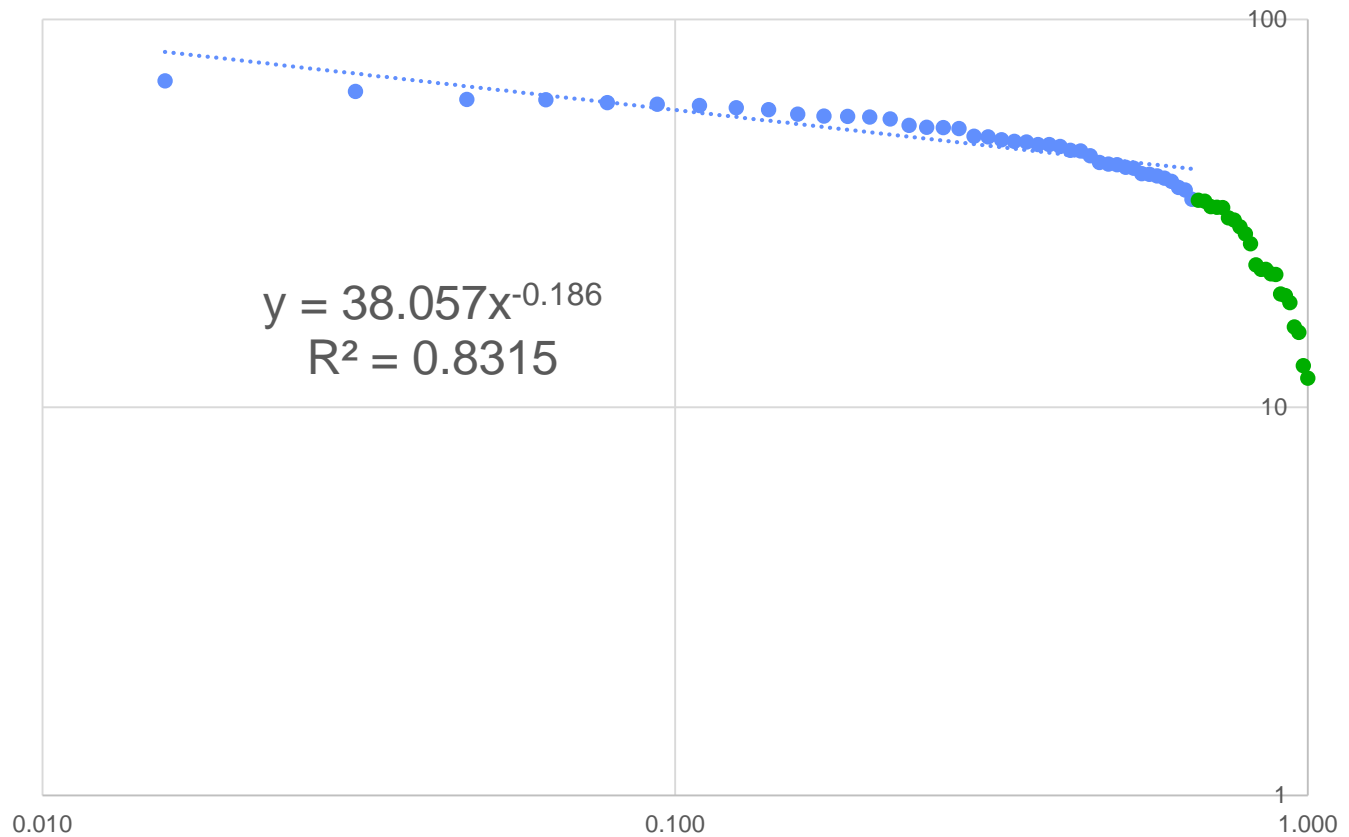


June 2017





September 2017





Findings

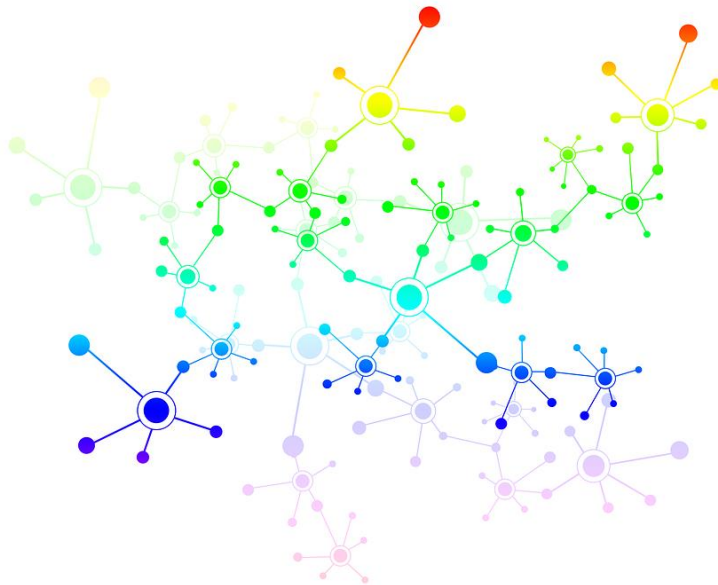
$$P(k) = ck^{-\gamma} \quad \text{para} \quad k_0 \leq k \leq K$$



- Where c is an appropriate normalization factor
- γ is the exponent of connections distribution
- k_0 is the minimum grade of any given node
- K cut degree depending on the network size



Properties: Scale free and Scale invariance



- So tourism occupancy distribution is preserved regardless of month and year
- Revealing tourism occupancy distribution is not random
- Similarities in distribution are sign of the common mechanism that exists in the process of choosing tourist destinations
- The kind of interrelations between occupancy rates and TA perturbations, from a complex system scientific point of view, can be considered as a response function of a social system with underlying dynamics leading to complex behavior



FUTUREWORKS

- Since the exponent of distribution is related to the fractal structure of a network we believe tourism mobility can be modeled with a pseudo fractal network
- Revealing some basic properties of the complexity in tourism dynamics mobility



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Felipe Lara, C3
Valentín Jiménez, TESOEM

Thank you