THE GEOGRAPHICAL HIERARCHY OF CONTAINER SHIPPING NETWORKS IN THE CARIBBEAN BASIN AND MEDITERRANEAN SEA

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Abstract

This paper develops two themes: To describe container liner shipping networks of the Caribbean and Mediterranean Seas for 1994 and 2002 at three geographical scales: intra-basin, regional and global, and to discuss the role that alliances, or alliance members before alliance creation, are playing in the network structures at the three scales in the two time periods. Findings indicate that the Mediterranean appears more developed, and becoming more so, than the Caribbean network. There is greater network development especially at the local or Intra-Basin level in the Mediterranean. Finally, the top ports in the Mediterranean remain so during the time period while in the Caribbean there appears to be instability. The one factor explaining these developments may be the greater maturity of the Mediterranean countries' economies where more containers are handled and more trade generated internally in the basin. Alliances and their members are important players in offering container services to the regions, Although alliances have expanded their networks in the time period studied they do not make up the majority of services, ports served or connections in either area. There would appear to be many opportunities for local and regional non-alliance carriers.

Keywords: Caribbean; Mediterranean; Container shipping; Networks; Alliances
Topic Area: A2 Maritime Transport and Ports

1. Introduction

Much attention on the container shipping industry over the past five years in academic and professional circles has focused on the formation and impact of strategic alliances. Research has shown that shipping alliances have established global networks that have radically changed container shipping services (Slack *et al* 2001). However, not all shipping lines are members of alliances; nor do all shipping lines attempt to be global players. Some operate globally but outside of alliance membership; some focus on inter-regional connections; some are only intra-regionally based; still others are very local in their service configurations. One can identify a geographical hierarchy of services from global through regional to local. Relatively little is known about the structure of the lesser networks of the hierarchy and the service connections they provide.

This paper has as its focus the shipping networks of two of the most important sub-global shipping areas of the world: the Caribbean basin and the Mediterranean Sea. There are two themes to this paper:

1. To describe container liner shipping networks of the Caribbean and Mediterranean Seas for 1994 and 2002 at three geographical scales: intra-basin, regional and global. Although similarities may exist between the Caribbean and the Mediterranean networks there are distinct differences.

2. To discuss the role that alliances, or alliance members before alliance creation, are playing in the network structures at the three scales in the two time periods. Do alliances threaten services provided by smaller carriers?

The year 1994 is chosen as the base year since it predates the alliances' creation.

2. A comparison of the Caribbean Basin and Mediterranean Sea

For our purposes the Caribbean Basin consists of the Caribbean Sea and the Gulf of Mexico; the Mediterranean Sea includes that sea and its many internal seas (Balearic, Tyrrhenian, Adriatic, Ionian, Sidra, Aegean, Marmara) but not the Black Sea. There are many comparisons that can be made between the two basins (Table1). Although the Caribbean Basin is larger in size, the coastlines are approximately the same length. More countries are found in the Caribbean but many (23) are small island economies. Economically the countries surrounding the Mediterranean are more developed than those of the Caribbean basin (if the US is excluded from the calculations). Both basins have a developed northern rim (the US for the Caribbean, Europe for the Mediterranean), emerging economies on the southern rim (South America for the Caribbean, North Africa for the Mediterranean) and island economies within the basins.

Both basins are semi-enclosed with strategic and economic points of egress/exit for container shipping: the Panama Canal for the Caribbean and the Suez Canal for the Mediterranean. Virtually all major container shipping lines of the world pass through the basins on their way to either, or both, of the two canals. The lines also make strategic stops within the basins at transshipment centres. Finally, there are many individual ports serving the interests of their immediate hinterland areas at which container ships make stops within the basins. How the service networks are configured and whether both basins have the same network development are key questions of the paper.

Table 1: A Comparison of the Caribbean Basin and the Mediterranean Sea

	Caribbean Basin	Mediterranean Sea
Size (km^2)	4,400,000	2,500,000
Coastline length (km)	56,000	51,000
Number of bordering countries	33	20
Population (estimates)	530,000,000	436,000,000
GNP of countries		
- including US	$10.7 Trillion	$3.7 Trillion
- excluding US	$927 Billion	
Per capita GNP of countries		
- including US	$20,977	$8,784
- excluding US	$4,096	

Sources: Economic statistics from http://www.worldbank.org/data/wdi2003/worldview.htm,.
Coastline lengths from http://earthtrends.wri.org/country_profiles/index.cfm?theme=1,
Population data from http://www.prb.org/pdf/WorldPopulationDS03_Eng.pdf

3. Data and methodology

The data on container services in the Caribbean and Mediterranean come from the *Containerisation International Yearbook*. As a commercial handbook, dependent upon the submission of information from the shipping lines themselves, its reliability and comprehensiveness may be questioned. There *are* errors in its reporting. It is, however, the only source of its type that provides the information required for this paper. Also, over its 35 years of existence it has built up a good record of credibility and usefulness.

Data were drawn for two years: 1994 and 2002. The former year predates major developments in container shipping. In terms of shipping lines and their services 1994

predates the formation of the major alliances: Maersk-Sealand, Grand, Global (later New World) and Hanjin Tricon (later United) which were all formed in 1996 (Midoro and Pitto 2000).

All the shipping line services operating in the two areas in those two years were recorded. For every service listed the shipping company, the ships assigned to the service, their capacity, the frequency of the service and the ports of call of that service were recorded. By knowing the ports of call service networks could be constructed. The *Yearbook* is not clear on the actual routes ships use. In order to construct the service networks it was assumed that ships called at the ports in their geographical order of proximity. For each service a line was drawn connecting nearest neighbour ports but the line was not closed. For example, if a route in the Caribbean included the ports of New Orleans, Houston, Veracruz and Kingston a line was drawn joining those ports in that order. Kingston and New Orleans were not joined. Some service routes just stopped at one port e.g. Freeport, Bahamas or Algeciras, Spain. In these cases the route is represented by a line joined to the port but not joined to any other port either in the Caribbean or Mediterranean. A GIS was used to record the ports and the service routes.

4. The networks

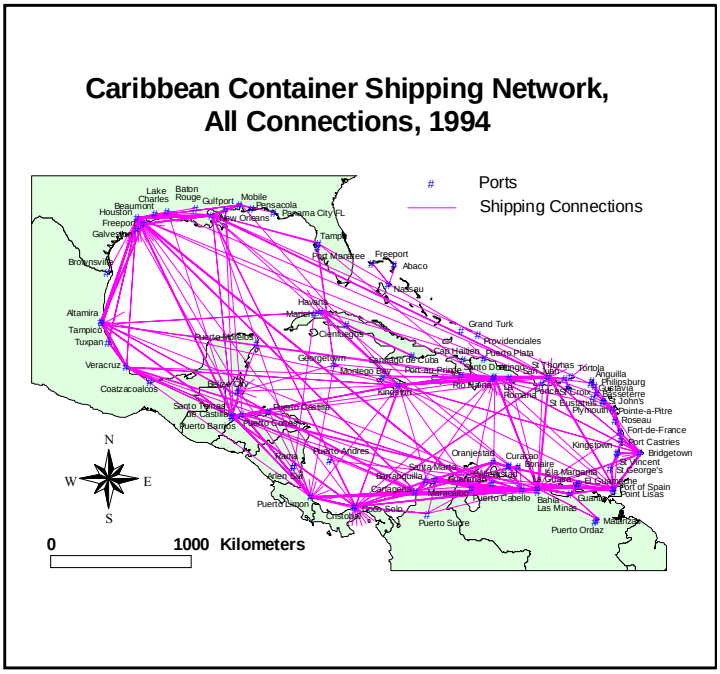
The container shipping networks of the Caribbean basin and the Mediterranean Sea for the two time periods are shown in Figures 1 and 2 respectively. Table 2 contains summary details of each of the networks.

Table 2: Summary Statistics on the Container Shipping Networks of the Caribbean Basin and Mediterranean Sea, 1994 and 2002

Caribbean Basin				
	Services	Ports	Connections	β[1]
1994	243	90	676	7.51
2002	215	88	584	6.37
% change	-11.5	-2.2	-13.6	-15.2
Mediterranean Sea				
	Services	Ports	Connections	β
1994	355	98	1076	10.97
2002	430	104	1244	11.96
% change	+21.1	+6.1	+15.6	+9.0

[1] β = Connections/Ports. It is a measure of network connectivity and redundancy.

Both Figures 1 and 2 and Table 2 show that the networks in both areas are very complex. There is a great deal of redundancy in the networks as evidenced by the β coefficient determined by dividing the number of connections or linkages among the ports by the number of ports. β can be thought of as the *average* number of 1st degree network connections each port has, but this number can be very misleading since the actual number of connections at the ports may be many times this average. For example, in 2002 there were 93 connections at Barcelona and 88 at Marseilles-Fos. Houston had 51 in 2002. Nevertheless, the β coefficient gives a descriptive measure of the *network* connectiveness.



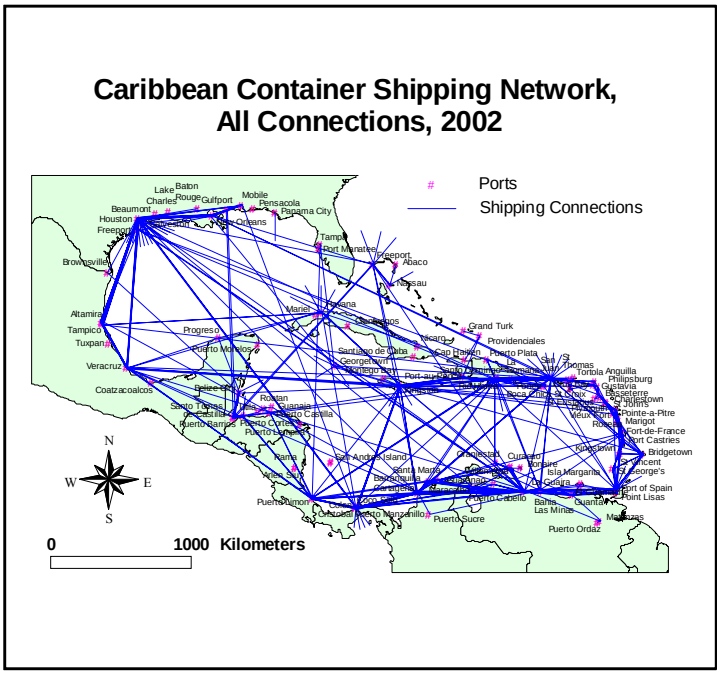
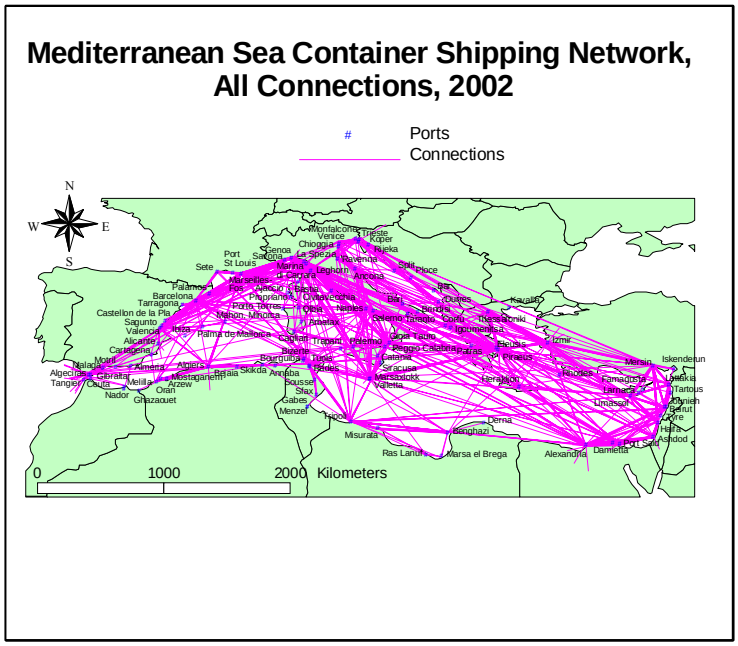


Figure 1: Caribbean Basin Container Shipping Networks, 1994 and 2002



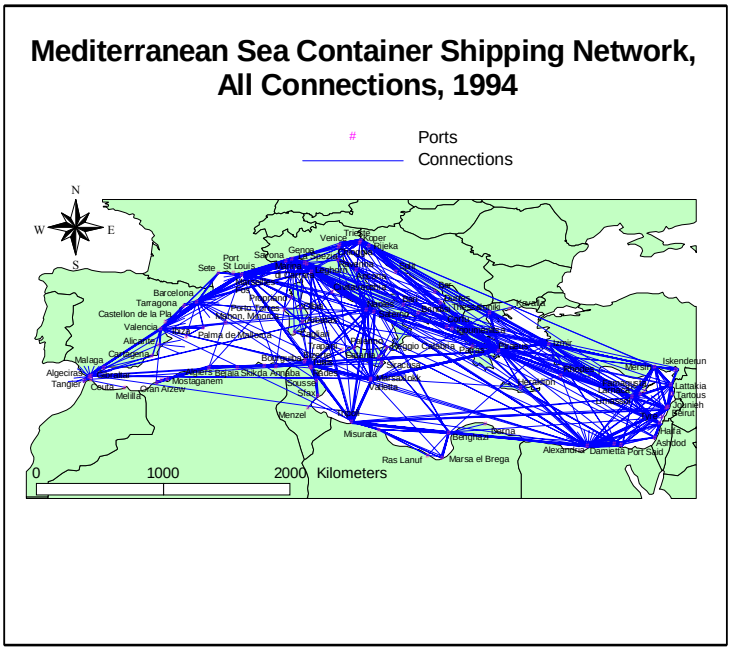


Figure 2: Mediterranean Sea Container Shipping Networks, 1994 and 2000

The Mediterranean networks are more developed than the Caribbean. There are more services, ports, connections and higher degrees of connectivity. Many factors may account for the greater development of container shipping networks in the Mediterranean. For one thing, the number of TEUs handled in Mediterranean ports is substantially more than in the Caribbean – 21.3 million compared to 12.8 million in the Caribbean in 2000. The increased activity may lead to more services and maritime port connections; alternatively, the more services and connections may generate more TEUs. There may also be more intra-basin trade in the Mediterranean. Table 3 verifies this point in terms of network complexity at the intra-basin level when the Mediterranean is compared to the Caribbean. Note the high number of services and connections at the intra-basin level in the Mediterranean compared to the Caribbean. The fact most of the economies of the Mediterranean countries are more developed and diverse than the vast majority of the Caribbean ones (US excepted) and there are greater complementarities among the countries for trade of raw materials, foodstuffs, semi-processed and processed goods may account for the increased intra-basin network complexity in the Mediterranean. There is also more of a maritime tradition in the Mediterranean than in the Caribbean which may lead to more shipping lines of different nationalities meeting the demands of their own countries as well as other countries bordering on the Mediterranean. There is more competition.

Table 3 also shows that the Caribbean and Mediterranean shipping networks have differences according to the geographical scale of services offered. Using the β coefficient as an indicator, the most developed (connected) network in 2002 for the Caribbean is the Inter-Oceanic one followed closely by the Intra-Basin one; for the Mediterranean it is the Intra-Basin network that is the most developed with the Inter-Oceanic one the least developed. This was not the case in 1994 where the Inter-Oceanic networks were the most developed in both the Caribbean and the Mediterranean. Obviously, changes are taking place over time to bring about different network structures at the different geographical scales. As is discussed below, one of the contributing factors may be the role of alliance carriers.

Differences in the two basins can also be seen in the connectiveness of ports. *Network* connectiveness can be defined by β, the *average* number of connections per port. *Port* connectiveness can be defined by number of port partners: the number of ports that can be reached from a port by the shipping services offered irregardless of the number of links required to make the connection. For example, a service may call respectively at Houston, New Orleans, Veracruz and Kingston. New Orleans is just one link away in the service from Houston while Veracruz and Kingston are two and three links removed from Houston. Regardless of the number of links each of these ports is a partner of the other. Table 4 gives the top connected ports in terms of port partners in both basins in both time periods.

While the number of port partners for the top connected ports in both basins is approximately the same, the Caribbean top ports are not as stable as the Mediterranean ones. In the Caribbean only Port of Spain and La Guaira remain in the list of top connected ports in 2002 compared to 1994. For the Mediterranean the same ports appear in both time periods as top connected ports although their order is somewhat different. It appears that the Caribbean is undergoing some fundamental changes in network structure, moreso than in the Mediterranean where networks are more developed and stable. This may be because of the economic maturity of the Mediterranean economies compared to the Caribbean.

Table 3: Breakdown of Container Shipping Service Networks by Geographical Areas Served in the Caribbean and Mediterranean, 1994 and 2002

Caribbean Basin											
1994											
Intra-Basin[1]				Regional – Americas[2]				Inter-Oceanic[3]			
Services	Ports	Con's	β	Services	Ports	Con's	β	Services	Ports	Con's	β
38	50	124	2.48	93	71	266	3.75	112	55	286	5.20
2002											
Intra-Basin				Regional - Americas				Inter-Oceanic			
Services	Ports	Con's	β	Services	Ports	Con's	β	Services	Ports	Con's	β
40	60	184	3.07	77	64	178	2.78	98	50	222	4.44
Mediterranean sea											
1994											
Intra-Basin				Regional – Europe/Africa				Inter-Oceanic			
Services	Ports	Con's	β	Services	Ports	Con's	β	Services	Ports	Con's	β
112	77	363	4.71	137	68	387	5.70	106	52	326	6.27
2002											
Intra-Basin				Regional – Europe/Africa				Inter-Oceanic			
Services	Ports	Con's	β	Services	Ports	Con's	β	Services	Ports	Con's	β
172	90	575	6.39	147	72	421	5.85	101	52	248	4.77

[1] Intra-Basin refers to shipping services which serve only basin ports.

[2] Regional-Americas and Regional-Europe/Africa refers to shipping services serving not only basin ports but also ports outside the basin in North or South America in the Caribbean context and Europe or Africa in the Mediterranean context.

[3] Inter- Oceanic refers to shipping services which serve basin ports and ports beyond the region, i.e. across other oceans.

Table 4: Ports with the Most Port Partners (PPs) in both Areas, 1994 and 2002

Caribbean Basin				Mediterranean Sea			
1994		2002		1994		2002	
Port	PPs	Port	PPs	Port	PPs	Port	PPs
Houston	51	Rio Haina	49	Marseilles-Fos	54	Marseilles-Fos	56
New Orleans	49	Port of Spain	46	Piraeus	54	Barcelona	52
San Juan	46	Kingston	44	Barcelona	51	Genoa	47
La Guaira	45	Puerto Cabello	43	Genoa	51	Piraeus	47
Port of Spain	45	La Guaira	42	Tunis	50	Tunis	45

In summary, the networks are complex. The Mediterranean appears more developed, and becoming moreso, than the Caribbean network. There is greater network development especially at the local or Intra-Basin level in the Mediterranean than the Caribbean. Finally, the top ports in the Mediterranean remain so during the time period while in the Caribbean there appears to be instability as new ports challenge the supremacy of older ones. The one factor explaining these developments may be the greater maturity of the Mediterranean countries' economies where more containers are handled and more trade generated internally in the basin.

5. The role of alliances

The formation of alliances in the container shipping world has been well documented (Notteboom and Winkelmans 2001, Heaver *et al* 2000, Midoro and Pitto 2000, Slack *et al* 2002, Frémont and Soppé 2003). Shipping companies have formed operational alliances with other ocean carriers, or outright mergers and acquisitions have occurred which have created larger companies with expanded service networks. In a previous paper we found

that the global networks of alliance services have expanded in the past 10 years permitting individual members to mount separate or joint services into lesser markets, thereby enhancing further the global character of container shipping (Slack *et al* 2001 Global Reach). One wonders what impact alliances and their members are having on network structures at the sub-global level. The Caribbean and Mediterranean networks under study here enable us to say something about this question.

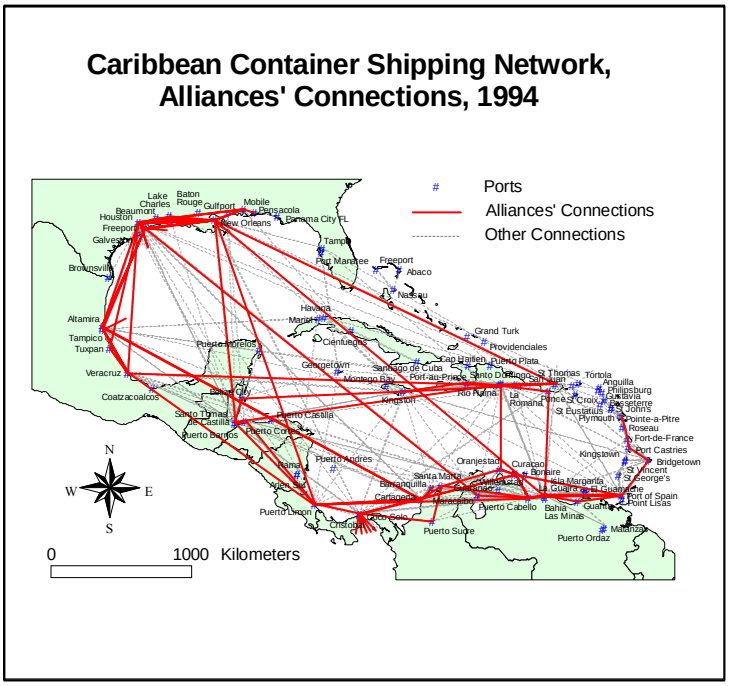
Activities of six alliances are isolated for analysis. These alliances are: Grand, United, New World; K Line, Yangming, Cosco; and CP Ships. Maersk-SeaLand is also included in the analysis although the alliance structure ended with the takeover of SeaLand by Maersk in 1999. Grand Alliance includes Hapag-Lloyd, P&O Nedlloyd, MISC, NYK and OOCL container lines. United consists of Hanjin, Cho Yang, DSR and Senator. HMM, APL (with NOL) and MOL make up the New World Alliance. CP Ships consists of the shipping lines owned by the company and operating in either the Caribbean or Mediterranean: namely, Lykes, TNN, Contship and Canada Maritime. All of these alliances were formed after 1994. In order to construct 'alliance' networks in 1994 the activities of individual shipping lines which came to form alliances were mapped. Figures 3 and 4 show the alliance services in the two basins; Table 5 summarizes their activity relative to the entire networks.

Table 5: Summary Statistics on the Container Shipping Services offered by Alliances or their members for the Caribbean Basin and Mediterranean Sea, 1994 and 2002

Caribbean Basin				
		Services	Ports	Connections
1994	Alliances	38	37	95
	All Lines	243	90	676
	% Alliances	**15.6**	**41.1**	**14.0**
2002	Alliances	57	42	147
	All Lines	215	88	584
	% Alliances	**26.5**	**47.7**	**25.2**
Mediterranean Sea				
		Services	Ports	Connections
1994	Alliances	48	37	136
	All Lines	355	98	1076
	% Alliances	**13.5**	**38.8**	**12.6**
2002	Alliances	74	40	184
	All Lines	430	104	1244
	% Alliances	**17.2**	**38.5**	**14.7**

[1] β = Connections/Ports. It is a measure of network connectivity and redundancy.

Based on Table 5 alliance operations are expanding in the two basins. In an absolute sense, the Mediterranean has more services, more ports of call and more connections offered by alliance members; but on a relative basis alliances are more involved in the Caribbean service structure than in the Mediterranean. Note that close to 50% of all Caribbean ports are called at by an alliance member in 2002 whereas not even 40% of all Mediterranean ports are served by alliances. Fully 25% of all services and connections in the Caribbean are by alliance members in 2002; these figures are less than 15% in the Mediterranean.



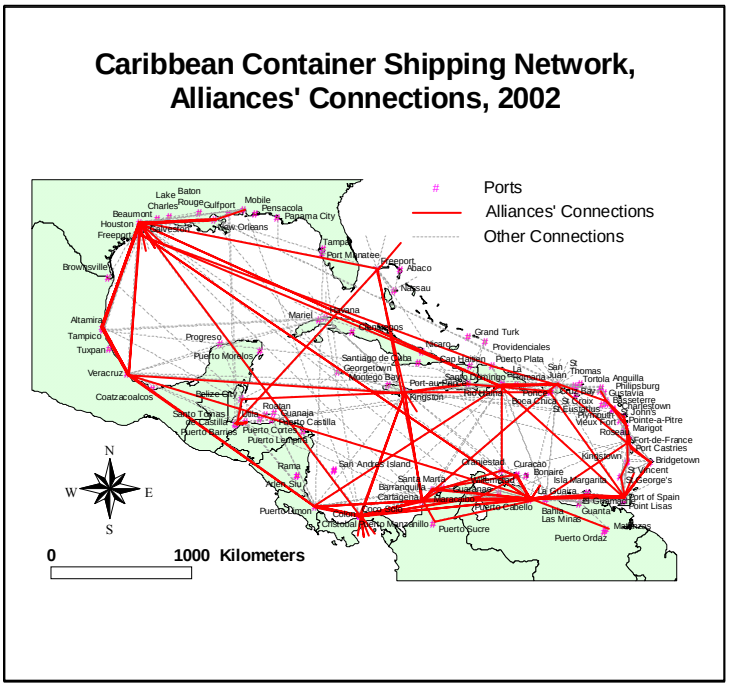
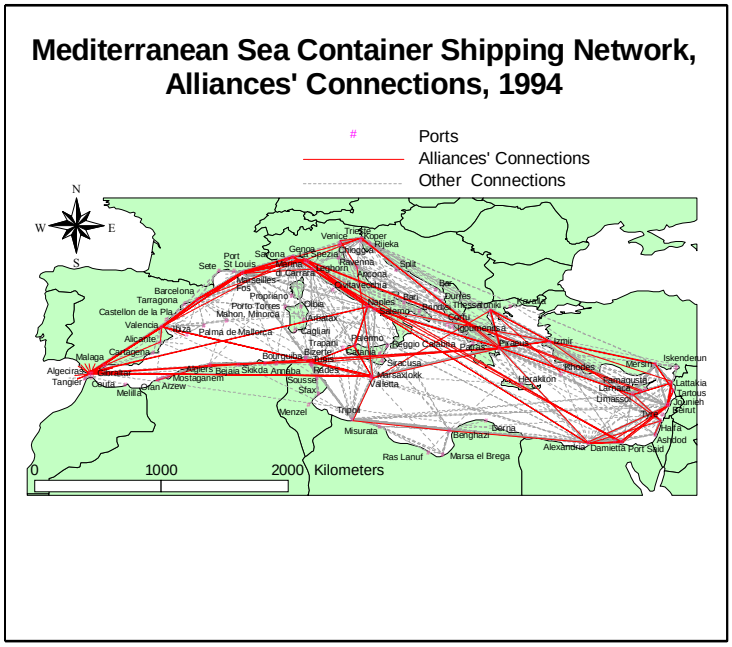


Figure 3: Alliances' Services, Caribbean Basin, 1994 and 2002



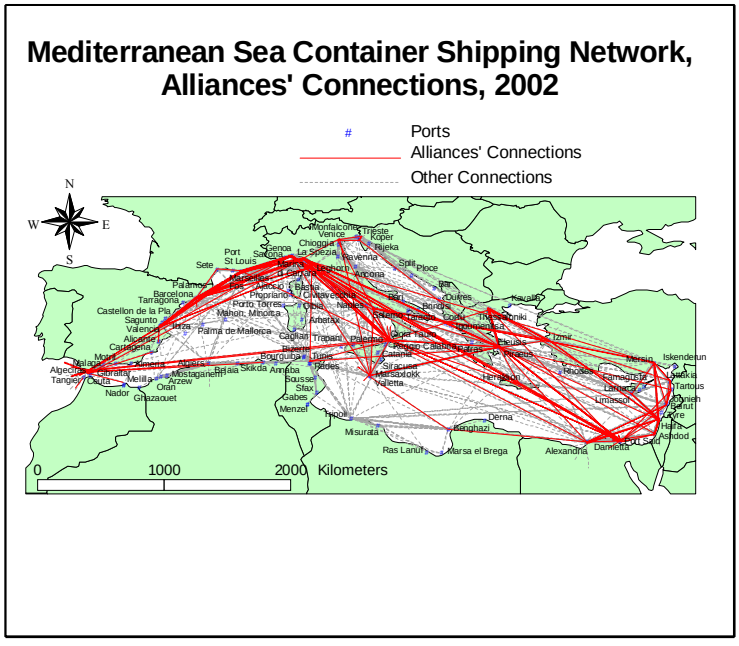


Figure 4: Alliances' Services, Mediterranean Sea, 1994 and 2002

Between the two time periods alliances have expanded their influence more in the Caribbean, even though the absolute number of services, ports called and connections by alliance carriers in the Mediterranean all show substantial increases between 1994 and 2002. These positive increases also exist in the Caribbean but they have a greater relative impact in the Caribbean because the overall network is contracting in size.

In terms of the geographical scale at which the alliances are having the greatest impact on a relative basis it is at the smaller scales where alliances are expanding their services (Table 6).

Table 6: Alliances' Network changes by geographical areas served, Caribbean Basin and Mediterranean Sea, 1994 and 2002

Caribbean Basin									
1994									
	Intra-Basin			Regional-Americas			Inter-Oceanic		
	Services	Ports	Con's	Services	Ports	Con's	Services	Ports	Con's
Alliances	2	8	7	9	19	19	27	31	69
All Lines	38	50	124	93	71	266	112	55	286
% alliances	5.3	16.0	5.6	9.7	26.8	7.1	24.1	56.4	24.1
2002									
	Intra-Basin			Regional-Americas			Inter-Oceanic		
	Services	Ports	Con's	Services	Ports	Con's	Services	Ports	Con's
Alliances	5	24	40	17	31	42	35	26	69
All Lines	40	60	184	77	64	178	98	50	222
% alliances	12.5	40.0	21.7	22.1	48.4	23.5	35.7	52.0	31.1
% change 1994-2002	135.8	150.0	287.5	127.8	80.6	231.0	48.1	-7.8	29.0
Mediterranean Sea									
1994									
	Intra-Basin			Regional-Europe/Africa			Inter-Oceanic		
	Services	Ports	Con's	Services	Ports	Con's	Services	Ports	Con's
Alliances	4	15	14	15	24	40	29	26	86
All Lines	112	77	363	137	68	387	106	52	326
% alliances	3.6	19.5	3.9	10.9	35.3	10.3	27.3	50.0	26.3
2002									
	Intra-Basin			Regional-Europe/Africa			Inter-Oceanic		
	Services	Ports	Con's	Services	Ports	Con's	Services	Ports	Con's
Alliances	12	24	31	21	24	58	41	26	95
All Lines	172	90	575	147	72	421	101	52	248
% alliances	6.8	26.6	5.3	14.3	33.3	13.7	40.6	50.0	38.3
% change 1994-2002	88.9	36.4	35.9	31.2	-5.7	33.0	48.7	0.0	45.6

Note the very high per cent increases in alliance services, ports called and connections at the intra-basin and regional levels for the Caribbean, and the not quite so large per cent increases at the intra-basin level in the Mediterranean. These high values are to be expected given the small 1994 base of alliance members' services offered in both the Caribbean and Mediterranean at the small geographical scales. The alliance members are all global carriers who initiated their alliances to expand their global reach. It would appear that once that goal had been met then the alliances focused on expanding their local and regional services to link up with the global expansion. This then, begs the question: is their room for small local carriers in the face of global alliance expansion at the smaller sub-global and even sub-regional level?

Our answer here is a qualified yes – qualified because it is based only on interviews held with Caribbean maritime transport representatives of shipping lines, freight forwarders and shipping agents. From our Caribbean interviews we can draw the following conclusions regarding the role of local and regional carriers in the basin, as opposed to alliance carriers passing through and serving the basin:

1. Local and regional carriers continue to play a major role in intra-basin trade. They may, though, lose trade to the alliance carriers in the international inter-oceanic trades and some of the major inter-regional trades in the basin to/from the United States. Because of economies of scale the small local carriers cannot compete on price with the large oceanic alliance carriers on deep-sea trades.

2. Local and regional carriers compete on service, not price. The small lines have long established customers to whom they allow flexibility of payments and timing of shipments (as examples of service characteristics which the large alliance carriers have difficulty matching).
3. Local and regional carriers are niche carriers specializing in either the transport of specialized goods (project cargo, for example) or services to/from very small ports or terminals where overheads and port costs are low.
4. There is room for the expansion of local carriers to act as feedering lines for the alliance carriers. Feeders offer dock-to-dock service with no logistics attached. Feeder lines can operate small flexible vessels with or without their own deck gear for loading/unloading containers. The key to their success is flexibility. Alliance carriers find it more difficult to be flexible in their operations as they operate to a fixed time and price schedule.

Based on these observations, it would seem that local and regional carriers have a future in the sub-global service areas. Even though alliance carriers have expanded their operations in both the Caribbean and the Mediterranean there would seem, still, to be many opportunities for small independent operators in the Caribbean, and we assume, the Mediterranean.

6. Conclusion

The service networks of container operations in the two basins under study are complex. There is much overlap between the services and the ports served. The services are provided by a variety of carriers ranging from the world's largest to one-ship small feeder operators.

The Mediterranean Sea networks are more developed than the Caribbean. There are more services and ports served with more connections. As well, there is stability over time in the major ports measured by the number of port partners. We suggest the reason for the greater development and stability is the more developed economies of the Mediterranean basin with countries having greater complementarities of trade goods than in the Caribbean.

Alliances and their members are important players in offering container services to the regions, but they do not make up the majority of services, ports served or connections. In fact, in some cases alliances offer a small proportion of the network services (less than 20 per cent of the 2002 Mediterranean network services and less than 15 per cent of the connections). Alliance members, though, may carry the majority of containers but our data do not show this. The data do show that the role of alliances in offering container services in the two basins is expanding. However, based on interviews in the Caribbean there are still many opportunities for local and regional non-alliance carriers.

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