Article

"Straits, Passages and Chokepoints: A Maritime Geostrategy of Petroleum Distribution"

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Cahiers de géographie du Québec, vol. 48, n° 135, 2004, p. 357-374.

Straits, Passages and Chokepoints
A Maritime Geostrategy of Petroleum Distribution

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Abstract

The transportation of petroleum represents one of the most strategically important circulations of resources in the global economy. Its role cannot be overstated. Yet, petroleum has become a "strategically invisible" commodity as its flow has been continuous with limited, but eye-opening, disruptions such as the First Energy Crisis is 1973. Petroleum supplies are virtually taken for granted. Since approximately two-thirds of the world's petroleum production is shipped by sea, there are inherent distribution constraints, which require navigating through straits and passages; chokepoints of maritime circulation. This paper presents an overview of the geography of oil supply and demand, and the strategic issues that are linked to its maritime circulation. Chokepoints are perceived as resources, the value of which varies according to degree of use. As the era of petroleum domination draws to a close, the importance and vulnerability of strategic passages will increase. Their ability to handle additional traffic appears to be limited, implying that future energy crises or oil shortages are more likely to be attributable to the challenges of distribution.

Keywords: **Petroleum Distribution, Maritime Transport, Strategic Passages, Hormuz, Suez, Malacca, Bab el-Mandeb, Bosphorus, Panama**

Résumé

Le transport du pétrole représente l'une des plus importantes circulations de ressources au sein de l'économie mondiale. Son rôle ne peut être exagéré. Cependant, le pétrole est devenu un produit de base «stratégiquement invisible» puisque sa circulation a toujours été continue, avec des ruptures alarmantes, mais limitées, telles que le premier choc pétrolier de 1973. L'offre de pétrole est pratiquement prise pour acquis. Puisque les deux tiers de la production pétrolière mondiale sont acheminés par voie maritime, il existe d'inévitables contraintes de distribution, parmi lesquelles l'utilisation d'un ensemble limité de détroits et passages: les goulots d'étranglement de la circulation maritime. Cet article se penche sur la géographie de l'offre et de la demande de pétrole, de même que sur les problèmes stratégiques liés à sa circulation maritime. Les goulots d'étranglement sont perçus en tant que ressources dont la valeur varie en fonction de leur niveau d'utilisation. Alors que la suprématie du pétrole tire à sa fin, l'importance et la vulnérabilité des passages stratégiques risquent de s'accroître en conséquence. Leur capacité d'admission des trafics supplémentaires apparaît limitée, ce qui implique que les futurs chocs (ou ruptures) pétroliers seront vraisemblablement liés à la problématique de sa circulation.

Mots clés: **Distribution du pétrole, transport maritime, passages stratégiques, Hormuz, Suez, Malacca, Bab el-Mandeb, Bosphore, Panama**

THE GEOSTRATEGY OF PETROLEUM

The Spice must flow.

Frank Herbert, *Spacing Guild. Dune*

This simple statement taken from an acclaimed science-fiction chronicle is an analogy of one of the core foundations of the global economy, to which there is currently no reasonable palliative or short-term alternative available. As Spice was to the fantasy future Empire, very few commodities are as vital as petroleum to the tangible operations of the real world. The flexibility of oil use has made it a remarkable commodity; it can be used as an energy source or lubricant and raw material in the manufacturing of plastics and fertilizers. It has even been argued that petroleum is too valuable a commodity to be used as fuel. As a commodity of strategic importance, petroleum has been, over the last century, the object of geopolitical conflicts for access, control and distribution. Although the energy intensity [1] of the global economy has declined, expanding oil consumption underlines a growing global dependency. The distribution of petroleum from oil fields to refineries and then to consumers cannot, under any circumstances, be interrupted in any significant manner. The fallout would be political and economic chaos, and a vulnerable and petroleum-dependent global economy could come to a grinding halt.

OIL SUPPLY STRATEGIES

To ensure a constant and uninterrupted oil supply, the strategies of industrialized nations have been articulated by the use of military force (primarily by the United States), economic incentives and uneasy alliances with oil producers, namely in the Persian Gulf. Access to this strategic location, especially Saudi Arabia, is likely to be the most important factor in contemporary energy geopolitics (Klare, 2001). The growing dependency among developed nations on external sources of oil reinforces these conventional strategic considerations, when a few key maritime passages chokepoints of the global economy are considered valuable resources with a rather fixed supply (Nincic, 2002). Moreover, increased Asian oil demand, especially within China, has caused a new shift in petroleum circulation and has stepped up competition over existing known oil resources, including the chokepoints themselves. The new geography of petroleum circulation is thus challenging conventional distribution networks, their security and their reliability.

Control of oil supply is becoming increasingly strained with limited alternatives other than to pursue policies and strategies implemented decades ago. For this reason, the Carter Doctrine, drafted to address the security of the Persian Gulf, grows more relevant after over 50 years of US military presence in the region.

> An attempt by an outside force to gain control of the Persian Gulf region will be regarded as an assault on the vital interests of the United States of America, and such an assault will be repelled by any means necessary, including military force. (President Jimmy Carter, State of the Union Address, January 23, 1980).

This doctrine was initially aimed at deterring the Soviet Union after its invasion of Afghanistan in 1979, but it has been implemented as the result of very different events and circumstances. With the former Cold War nemesis gone, the hostile force turned out to be from within the Gulf region itself: Iraq. The Carter Doctrine has been implemented twice; in 1990 during the First Gulf War and in 2003 for the Second Gulf War. In the first case it was to quell the intentions of Iraq to gain control over a large portion of regional oil fields with damaging economic and political potential. In the second case, a hidden agenda was to ensure future stability in the Persian Gulf region and hence, its oil supplies. The policy, however, came at a huge economic and political cost, which can be viewed as a subsidy for stable oil supplies, paid by the end consumer. The cost of securing access to Middle Eastern oil, ranging from deployment of forces in the Persian Gulf, the patrol of its water and the supply of military assistance to nations in the region is estimated to be in the range of US$50 billion a year (IAGS, 2003). The cost of the First Gulf War was over US$80 billion, while the final cost of the Second Gulf War has yet to be tallied and could range anywhere between US$125 billion to US$1 trillion, including costs for security and to rebuild. Securing oil resources has thus become a complex and expensive undertaking.

OIL CIRCULATION AND CHOKEPOINTS

The whole issue of oil dependency among nations that lack political stability or reliability opens the door to occasional disruptions, price changes and a transfer of wealth. According to the US Department of Energy, the cost of political instability has been over US$3.4 trillion in the last 30 years, and the transfer of wealth to oil exporters has accounted for US$1.16 trillion over the same period. The post-September 11 era is one of realization of the geopolitical consequences this transfer has had on stability in the Middle East and the acknowledgement that petroleum must continue to flow regardless. Price fluctuations of the commodity itself have been substantial and are often linked to periods of growth and recession of the global economy (Hamilton, 1985). In spite of all the concerns and calls to action, the ability to substitute for alternative energy sources remains limited (Rifkin, 2002). Under such circumstances, the global economy will remain dependent and vulnerable to the circulation of oil, especially over its chokepoints, for at least the first two decades of the XXIst century.

Chokepoints are a common concept in transport geography, as they refer to locations that limit the capacity of circulation and cannot be easily bypassed, if at all. This implies that any alternative to a chokepoint involves a level of detour or use of an alternative that translates into significant financial costs and delays. They can also be perceived as a resource whose usefulness varies with the ebb and flow of the geography of circulation. Considering the characteristics of maritime transportation, maritime chokepoints are particularly prevalent. Many of them are the result of the constraints of physical geography while others, namely Suez and Panama, are artificial creations. Three core concepts thus define a chokepoint as a resource:

- **Physical characteristics**. To begin, a chokepoint is a location that forces traffic to converge and, by virtue of its physical characteristics, namely depth, width

or navigability, limits movement. Its physical capacity to accommodate maritime circulation is thus limited.

- **Usage.** The value of a chokepoint is proportional to its degree of usage and the availability of alternatives. The fact that a chokepoint acts as a limit to circulation imposes a threshold to its use. The closer the traffic is to this threshold, the more the resource is deemed to be exhausted.

- **Access**. As a valuable resource, some degree of control must be established to ensure access to the chokepoint. This requires agreements to regulate use and settle disputes if access becomes contested. Tolls can also be levied if the chokepoint falls within a well-defined jurisdiction to control access to infrastructures such as locks.

Although the physical characteristics of most chokepoints are very stable, implying a fixed capacity, their use and value can fluctuate significantly. With the growth of maritime circulation and global trade, many have become extremely valuable resources, and represent some of the most important strategic locations in the world. Like all fixed supply resources, however, there is a limit to which they can be used. The closer they come to exhaustion, the more unstable their use and the more effort required to secure access.

This paper reviews contemporary evidence related to oil supply, demand and distribution. Although petroleum-related strategic and economic issues are understood and have been discussed at length (Yergin, 1991; Venn, 1986), the unique geography of global petroleum distribution, including its maritime chokepoints certainly merits review. The principal argument is that distribution is as important as production and pricing issues, since distribution is a fundamental factor to ensuring that supply meets demand. We begin by discussing the complex relationship between petroleum and the global economy, particularly in terms of supply, demand, reserves and distribution. Given the importance of distribution, we follow with an analysis of the major chokepoints in the maritime circulation of petroleum. Even as the era of petroleum dominance draws to a close, the significance of these chokepoints is likely to increase with shrinking supply and growing demand, particularly from Pacific Asia.

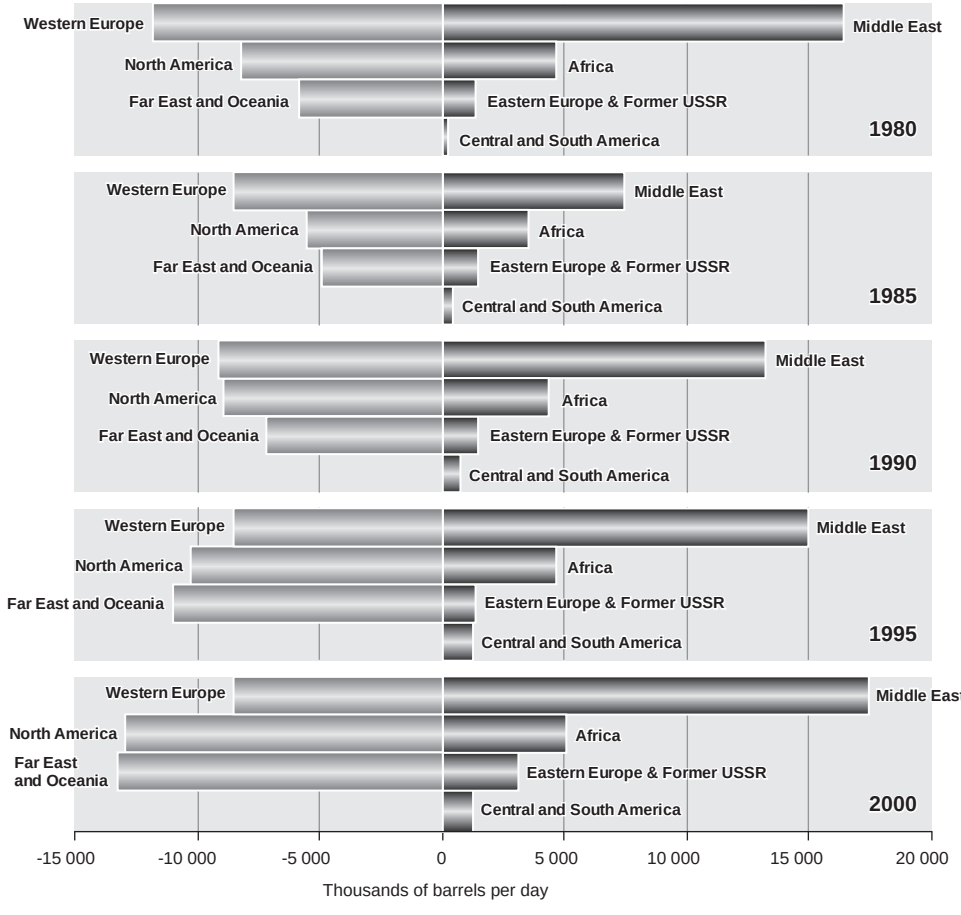
PETROLEUM AND THE GLOBAL ECONOMY

PETROLEUM PRODUCTION AND CONSUMPTION

The oil industry is oligopolistic in terms of supply, demand, control, function and geographical concentration (Clo, 2000). Demand is controlled by a few very large multinational conglomerates, each with its own production and distribution systems that include refineries, storage facilities, distribution centres and, at the end of the supply chain, gas stations. Supply is controlled by a few countries where the oil industry is often nationalized or under a uniform price-fixing policy of OPEC [2], which controls approximately 37% of world oil production. The geography of production and consumption is characterized by a strong spatial differentiation of supply and demand. Due to geographical and geological factors, oil is produced

primarily far from where it is consumed, resulting in acute disparities, which are growing rapidly (figure 1). A number of developed nations, including the United States, have extracted most of their oil reserves and are gradually shifting to foreign sources [3]. This trend can only be overcome by massive oil transportation infrastructures, including pipelines, terminals, tankers and storage facilities.

Figure 1 World Oil Balance, 1980-2000



Sources: US Energy Information Agency, International Energy Annual Report

Figure 1 shows the global geography of oil characterized by surpluses and shortfalls. While the Middle East has the largest surplus (17.3 Mb/d [4] for 2000), Pacific Asia, North America and Western Europe, all have significant shortfalls (13.2, 12.9 and 8.5 Mb/d respectively).

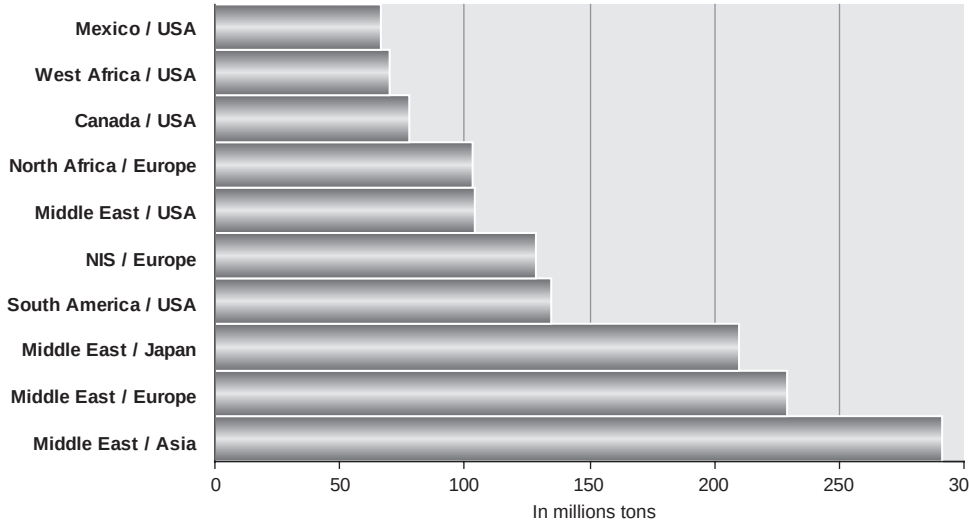
Global oil reserves are highly concentrated, with 64% of proven reserves located in the Middle East. The question remains about the amount of oil reserves that are economically available and how long they will last. Figures about the planet's oil reserves are thought to have been between 2100 and 2800 billion barrels before oil

development began in the XIXth century. As of 2001, an estimated 1020 billion barrels of proven oil reserves were available and 900 billion barrels have been extracted, which represents approximately one-third of all available oil reserves [5]. To this figure, can be added between 200 to 900 billion barrels of oil that potentially remain to be found (Campbell and Laherrere, 1998). Based on these figures, global oil production should peak around 2005-2010 and then begin to decline. In a long-term perspective, control by OPEC will grow since the bulk of remaining oil reserves is located within its jurisdiction. Saudi Arabia alone accounts for approximately 25% of the world's total oil reserves, putting upward pressure on energy prices.

Oil production steadily increased in the second half of the XXth century to meet growing demand. On average 68 million barrels of crude oil are produced each day (2000 figures), 32% of it in the Middle East, the single most important oil-producing region in the world. Approximately 60% of the total oil currently produced has already been committed and 40% is sold on open markets. More significantly, the capacity and geographical origin of surplus oil production is limited and 90% of this surplus oil production is in the Persian Gulf. In addition to accounting for the world's largest oil reserves, Saudi Arabia holds an added advantage as the only major supplier able to increase production immediately, when needed. Surplus production capacity is crucial in the event of a major supply disruption since capacity can be immediately increased to maintain current oil supply levels. Recent events, such as the conflict in Iraq and civil unrest in Venezuela and Nigeria, have stretched the world's extra capacity thin to about one million barrels a day in 2003. Additional sources of oil are thus scarce and when they are located, the ability to develop and transfer oil to markets takes several years.

The global economy has become dependent on cheap oil, the United States being the most powerful example (Greene *et al.*, 2002). Since transportation activities account for 52% of total oil consumption, motorization is one of the driving forces behind petroleum consumption. An average 77.5 Mb/d were consumed in 2002, 57% of it in developed nations. While the United States rank as the leading global consumer of oil (20.1 Mb/d), the rapid growth of the Chinese economy over the last decade has propelled China to the second rank of oil consumers (5.5 Mb/d), surpassing Japan (5.3 Mb/d). China accounts for approximately 40% of global growth in oil demand in recent years. Almost 55% of total oil consumed in the United States was imported in 2002. This figure is expected to rise to 65% by 2010. Demand is also subject to some degree of seasonality, with increased use for heating oil in winter and higher gasoline demand in the summer. Depending on the economic sector, price elasticity ranges from small to significant. While a growth in oil prices may adversely impact air transportation, car-dependent commuters are much more likely to bear the increase. Other industrial sectors are also significantly affected by oil prices, notably plastics and fertilizers. Higher energy prices are likely to further stimulate relocation to lower cost locations as manufacturers try to reduce the costs over which they have some control, such as labor, real estate and taxes.

Figure 2 Inter-Regional Petroleum Movements, 1998 (in million tons)



Source: OECD

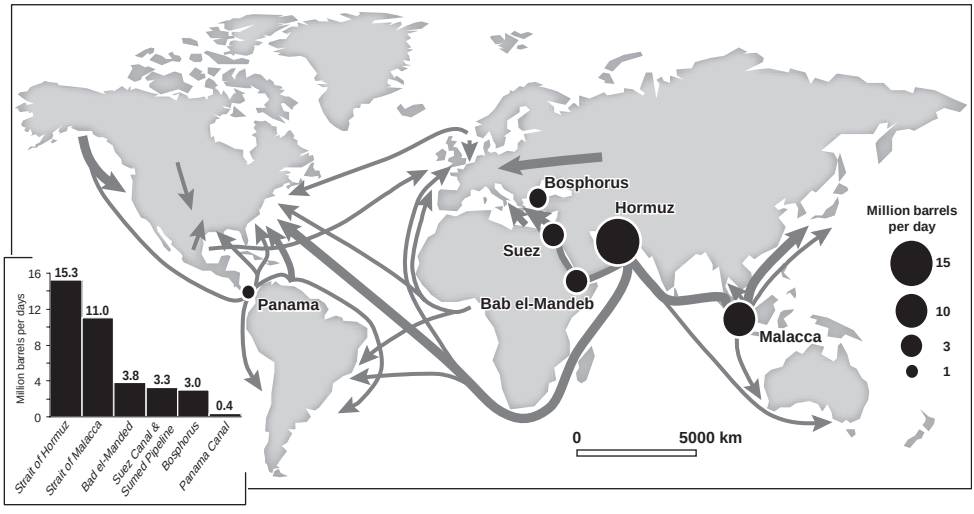
The international oil trade is correlated with oil prices and transport costs, and oil flows are often linked to the proximity of suppliers and consumers (figure 2). Since the 1970s, there has been a shift in the global flows of petroleum, which were dominated by flows from the Middle East to Western Europe and North America. There has been an acceleration of the trend that began with the re-industrialization of Japan after World War II. Development of the "Tigers" – South Korea, Taiwan, Hong Kong and Singapore – has brought with it growing oil demand in Pacific Asia and a corresponding shift of oil flows predominantly served by the Middle East. The growth of China, however, is the single most important factor in the increase of global oil demand, and raw materials in general, since it squeezes supply and drives prices upwards.

PETROLEUM TRANSPORTATION

Petroleum transportation is one of the best examples of a derived transport demand as its circulation is a direct consequence of consumption. This tightly integrated distribution network involves a continuous flow from the oil fields to the final consumption, with rather limited storage outside of strategic reserves [6]. The volume of international oil trade increased as a result of world economic growth and higher energy demand. The largest oil consumers are the most highly-developed nations, including the United States, Western Europe and Japan, which account for approximately 75% of global crude oil imports. International oil trade is necessary to compensate for the spatial imbalances between supply and demand (figure 1). Unlike most other countries, which either consume almost their entire production (United States) or have privileged partners (Russia and Western Europe), a major portion of OPEC's oil is traded on international markets.

Since the first oil tanker began shipping oil in 1878 in the Caspian Sea, the capacity of the world's maritime tanker fleet has grown substantially, to become a specialized segment of the maritime industry (Ratcliffe, 1985). Each year, approximately 1.9 billion tons of petroleum are shipped by maritime transportation, which is roughly 62% of all petroleum produced and 37% of total tonnage and 44% of total tons/km shipped by maritime transportation. The remaining 38% use pipelines, trains or trucks over smaller distances. Most of the petroleum follows a set of producing and consuming shipping lanes (figure 3). Over 100 million tons of oil is shipped each day by tanker, almost half of which is loaded in the Middle East and shipped to Japan, the United States and Europe. Tankers bound for Japan use the Strait of Malacca, while tankers bound for Europe and the United States use either the Suez Canal or the Cape of Good Hope, depending on the tanker's size and the destination.

Figure 3 Oil Flows, Major Chokepoints and Oil Transited at Major Strategic Locations, 2003



Source: Energy Information Administration (2003)

The world tanker fleet capacity (excluding tankers owned or chartered on a long-term basis for military use) represented approximately 280 million deadweight tons in 2002. There are roughly 3500 tankers available on the international oil transportation market. The cost of hiring a tanker is known as the charter rate. It varies according to the size and characteristics of the tanker, its origin, destination and the availability of ships, although larger ships are preferred due to the economies of scale they offer. Approximately 435 VLCCs [7] account for one-third of all the oil carried. Tanker ships can also be used as semi-permanent storage tanks. In 1990, about 5% of the world's tanker capacity was used for this purpose.

The size of a tanker determines the route it takes, due to distance and port access constraints. Maritime oil transportation is therefore specialized in terms of ship size, according to the markets served. VLCCs are used mainly from the Middle East to cover long distances (Western Europe, United States and Pacific Asia).

"Suezmax" [8] tankers are used mainly for long to medium hauls between West Africa and Western Europe and the United States, while "Aframax" [9] tankers are used for short to medium hauls, such as between Latin America and the United States. Transport costs have a significant impact on market selection. For instance, three-quarters of United States oil imports originate from the Atlantic Basin (including Western Africa), with journeys of less than 20 days. Venezuelan oil takes about 8 days to reach the United States, while Saudi oil takes 6 weeks. The vast majority of Asian oil imports come from the Middle East, a 3-week journey. Moreover, due to environmental and security concerns, single-hulled tankers are gradually being phased out and replaced by double-hulled tankers (Timmons, 2004).

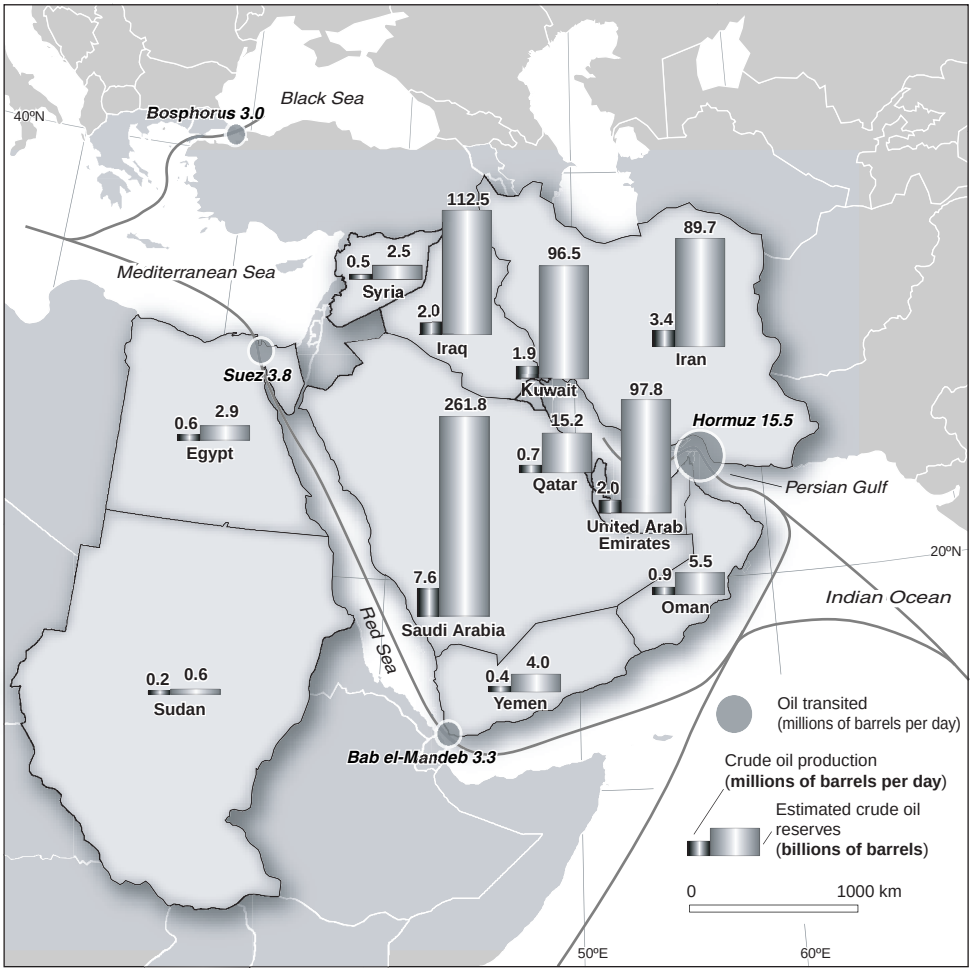
Transportation costs account for a small percentage of the total cost of gasoline at the pump, about 5 to 10% of the added value of oil. As United States dependency on oil imports increases and as new consumers create additional demand, more pressure will be felt on oil circulation chokepoints.

STRATEGIC PASSAGES: CHOKEPOINTS OF THE GLOBAL ECONOMY

Maritime transportation, as the dominant purveyor of international freight distribution, operates over a global maritime space. This space has its own constraints, however, such as the profile of continental masses. International shipping lanes are forced to go through specific locations such as passages, capes and straits. There are approximately 200 of these locations, but only a handful are of strategic importance. By definition chokepoints tend to be shallow and narrow, impairing navigation and their capacity is being challenged by growing maritime circulation and larger ships (Feller, 2004). Many chokepoints are in close proximity to politically unstable nations, which increases navigation risks and compromises access and use. In recent years, the threat of terrorism has raised additional concerns over maritime circulation (Richardson, 2004). Strategic passages can be mined, blocked by sinking ships, or interdicted by naval forces, artillery or missile systems. Chokepoints truly are the geographical Achilles heels of the global economy.

The geostrategy of maritime petroleum circulation involves six major chokepoints (figure 3), which handle over 35 Mb/d. Their use is shared with regular flows of commercial maritime shipping, including containers and other cargos. Two are extremely important: Hormuz and Malacca, since they account for over 60% of oil transits. Hormuz represents the most important strategic passage in the world, solely because of its access to the oil fields of the Middle East, while Malacca is an active commercial point of transit between the Indian and Pacific Oceans. From the Persian Gulf, two major axis of oil circulation serve Western Europe and the United States (westbound) and Pacific Asia (eastbound). As eastbound and westbound oil shipments grow, so too does the need to maintain the integrity of the strategic passages that support its trade. This is particularly the case for China, since its oil imports stretch from the Strait of Hormuz, Malacca and the South China Sea, most of which are patrolled by the United States.

Figure 4 Shipping Lanes and Strategic Passages in the Middle East

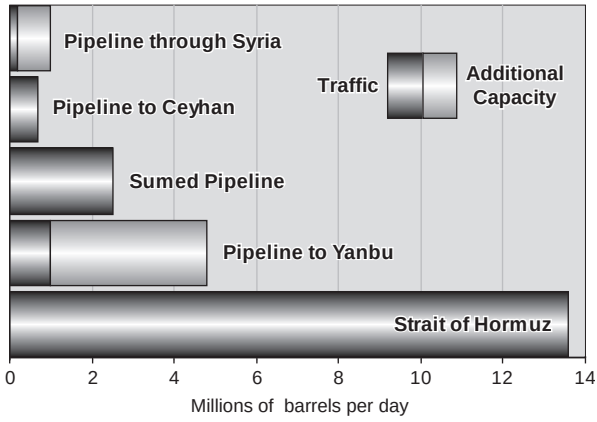


STRAIT OF HORMUZ

The Strait of Hormuz forms a strategic link between the oil fields of the Persian Gulf, the Gulf of Oman and the Indian Ocean (figure 4). It is 48 to 80 km wide, but navigation is limited to two 3-km-wide channels, each used exclusively for inbound or outbound traffic. Circulation in and out of the Persian Gulf is therefore extremely confined, because the sizable number of tankers makes navigation difficult along the narrow channels. In addition, islands that ensure control of the strait are contested by Iran and the United Arab Emirates. Security within the strait has often been compromised. Between 1984 and 1987 there was a "Tanker War" between Iran and Iraq, during which each party, in their own belligerence (Iran-Iraq War of 1980-1988), began firing on tankers, even neutrals, bound for their respective ports. Shipping in the Persian Gulf dropped 25%, forcing the intervention of the United States to help secure oil shipping lanes.

Approximately 88% of all the petroleum exported from the Persian Gulf transits through the Strait of Hormuz, bound to Asia, Western Europe and the United States. Its importance in global oil circulation cannot be overstated. For instance, 75% of all Japanese oil imports transit through the strait. There are thus very few alternative outlets for oil exports from the Persian Gulf if the traffic, which represents approximately 14 Mb/d, going through Hormuz was compromised (figure 5). Moreover, an unannounced closure of the strait would trap roughly 7 to 10% of the global VLCC fleet in the Persian Gulf.

Figure 5 Oil Exports from the Persian Gulf per Outlet, 2002



The only other significant outlet for Persian Gulf oil is the pipeline to the Saudi Arabian port of Yanbu on the Red Sea, which can handle approximately 4.8 Mb/d. The Sumed pipeline, which runs relatively parallel to the Suez Canal is also indirectly an outlet of the Persian Gulf but would be dependent on the capacity to ship Middle Eastern oil (mainly Saudi) to the Red Sea either by pipeline (Yanbu) or through Bab el-Mandeb. The other two pipelines link northern Iraq (Kirkuk region) to Syria or Turkey (port of Ceyhan on the Mediterranean) and do not offer significant additional capacity.

SUEZ CANAL AND STRAIT OF BAB EL-MANDEB

The opening of the Suez Canal in 1869 ushered in a new era of European influence in Pacific Asia. The journey from Asia to Europe was remarkably reduced, by saving 6500 km from the circum Africa route. The canal has no locks, because the Mediterranean Sea and Gulf of Suez have roughly the same water level. In 1874, Britain bought the shares to the Suez Canal Company. Under the 1888 agreement, the canal was to remain open to vessels from all nations in time of peace or war. Great Britain, however, claimed the need to control the area in order to maintain its maritime power and colonial interests (namely in South Asia). In 1936, it acquired the right to maintain defense forces along the Suez Canal, which turned out to be of strategic importance during World War II to uphold Asia-Europe supply routes for the Allies.

The second half of the XXth century saw renewed geopolitical instability in the region with the end of colonialism and the emergence of Middle Eastern nationalism. In 1954 Egypt and Great Britain signed an agreement that superseded the 1936 treaty and provided for the gradual withdrawal of all British troops from the Canal Zone. All British troops were withdrawn by June 1956 as the canal was nationalized by Egypt. This triggered problems with Israel, as Israeli ships were not permitted to cross the canal. This threat was also extended to France and Britain, the former owners of the canal because they refused to help finance the Aswan High Dam project, as initially promised. Israel, France and Britain thus invaded Egypt in 1956. Egypt responded by sinking ships in the canal, effectively closing it between 1956 and 1957. An agreement regarding use of the canal was subsequently reached.

Geopolitical problems persisted, however, as tensions between Israel and Arab nations increased in the 1960s. The Six Days War between Israel and Egypt and the invasion of the Sinai Peninsula by Israel caused the Suez Canal to close between 1967 and 1975. This event significantly destabilized international transportation and favoured the development of ever larger tankers for use along the lengthy circum Africa route. The canal was re-opened in 1975 and Egypt agreed to allow Israel to use it. Significant improvements were made between 1976 and 1980, mainly widening of the canal to accommodate 200 000-ton VLCCs, ensuring the oil trade between Europe and the Middle East. The minimum width of the channel is 60 metres and ships with up to 16 metres (58 feet) of draft can make the transit. This means that ULCCs cannot pass through the Canal when fully loaded. A common practice is to unload parts of Mediterranean-bound ships and use the Sumed pipeline. Through additional deepening and widening projects, the depth of the canal is expected to reach 22 metres by 2010.

The canal can accommodate up to 25 000 ships each year, but handles approximately 14 000, which is 38 ships each day on average, accounting for 14% of the global trade. Since the canal can handle only unidirectional traffic, crossings must be organized into convoys of about 10-15 ships. Three convoys each day, two southbound and one northbound, are organized. Missing a convoy causes additional delays. Many maritime companies therefore choose to skip a port call to ensure that their ship arrives on time at the Suez Canal to be part of a specific convoy.

The Strait of Bab el-Mandeb, a strategic link between the Indian Ocean and Red Sea, controls access to the Suez Canal. The large amount of tanker traffic makes navigation difficult along the narrow channels. A closure of this strait would have serious consequences, since it would force a detour around the Cape of Good Hope and in the process require additional tanker space.

BOSPHORUS

The Passage of Bosphorus is 30 km long and 1 km wide at its narrowest point, linking the Black Sea to the Mediterranean Sea (figure 4). Two conflicts have erupted over this passage, namely the Crimean War (1854) and the Battle of the Dardanelles (1915). The passage was fortified by Turkey after the Convention of Montreux in 1936, which recognized its control of Bosphorus but granted free passage in peace time to any commercial vessel without inspection. With the passage of the

Dardanelles, Bosphorus forms the only link between the Black Sea and Mediterranean Sea. In light of current world affairs, the Bosphorus represents a passage of growing strategic importance, notably after the fall of the Soviet Union. The Caspian Sea has vast oil reserves and a large amount must likely transit through the Black Sea and Bosphorus to reach outside markets, namely around the Mediterranean Sea. Although pipelines offer an alternative, the cost differentials favour use of maritime transportation. For instance, the cost of moving oil along the Baku-Ceyhan pipeline ranges between US$1 and US$2 per barrel, whereas shipping oil by tanker through the Black Sea costs 20 cents per barrel (Brito, 1999).

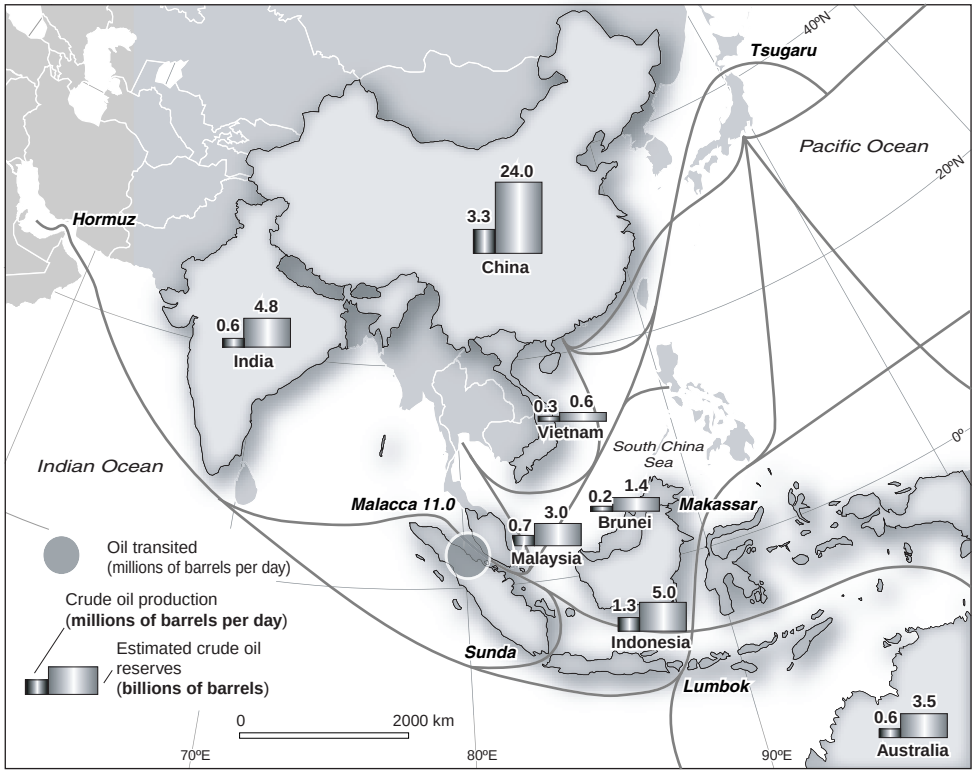
Approximately 50 000 ships, including 5500 tankers, transit through the passage each year, which is approaching capacity. The physical limits of the strait can accommodate tankers to a maximum capacity of 200 000 dwt. The amount of oil transiting through the Bosphorus has growth significantly in recent years, with the development of oil fields around the Caspian Sea. Approximately 3 Mb/d were transiting through the passage in 2003. Future growth of petroleum circulation through Bosphorus is therefore highly problematic, notably the risk of collision and oil spills in the midst of Istanbul. In response, the Turkish government prohibited, in 2002, use of the passage during the night by large tankers.

STRAIT OF MALACCA

The Strait of Malacca is one of the most important strategic passages in the world because it supports the bulk of the maritime trade between Europe and Pacific Asia, which accounts for 50 000 ships each year (600 per day). The strait is approximately 800 km long and between 50 to 320 km wide (2.5 km at its narrowest point) and has a minimum channel depth of 23 metres (roughly 70 feet). It is the longest strait in the world used for international navigation. Close to 30% of the world's trade and 80% of petroleum imports to Japan, South Korea and Taiwan transit through the strait, which represented approximately 11 Mb/d in 2003. As the main passage between the Pacific and Indian Oceans, Malacca is an unavoidable bottleneck, with the Strait of Sunda (Indonesia) being the closest alternative (figure 6).

For centuries, the Strait of Malacca has been part of the Arab trade routes linking the Middle East, Southeast Asia and China. By the early XVIth century the Portuguese conquered the stronghold of Malacca, a key trading centre after which the strait bears its name. In 1867, England formally took control of the passage. Singapore became a main harbour and other important centers, such as Malacca and Penang, formed the Strait Settlements. This control lasted up to the Second World War and the independence of Malaysia in 1957. As Pacific trade swelled after the Second World War, so too did the importance of the passage. Singapore, located at the southern tip of the Strait of Malacca, is one of the most important ports in the world and a major oil refining centre. Dredging is one of the main problems of the Strait of Malacca, since some sections are barely deep enough to accommodate ships of approximately 300 000 deadweight tons. Because the strait is located between Malaysia, Indonesia and Singapore, it is difficult to reach an agreement about how the dredging costs should be shared and how fees for its use should be levied. Political stability and piracy are also major issues for the safety of maritime circulation, especially on the Indonesian side.

Figure 6 Shipping Lanes and Strategic Passages in Pacific Asia



The Strait of Malacca leads to the South China Sea, another extremely important shipping lane and a region subject to contention, since oil and natural gas resources are present. The Spartly [10] and Paracel groups of islands are claimed in whole or in part by China, Vietnam, Malaysia, Indonesia, Brunei and the Philippines. The region has proven oil reserves estimated at 7.0 Bb with oil production accounting for 2.5 Mb/d. Given the substantial economic growth in the region, large flows of oil, liquefied natural gas and other raw materials (iron ore, coal) are transiting towards East Asia. About 25% of the global shipping fleet transits through the region each year, underscoring the importance of the South China Sea as an extension of the Malacca chokepoint.

PANAMA CANAL

The Panama Canal joins the Atlantic and Pacific Oceans across the Isthmus of Panama in Central America. Running from Cristobal on Limon Bay, an arm of the Caribbean Sea, to Balboa, on the Gulf of Panama, the canal is slightly more than 64 km in length. Its operational characteristics involve a minimum depth of 12.5 m and a minimum width of 91.5 m. Its construction ranks as one of the engineering

marvels of all time, since it averts a long detour around South America, thus supporting the maritime flows of world trade. The Panama Canal is strategically important to the United States because it is a rapid link between the east and west coast, saving approximately 13 000 km (from 21 000 km to 8000 km). It is comprised of three main elements, the Gatun Locks (Atlantic Ocean access) the Gaillard Cut (continental divide) and the Miraflores Locks (Pacific Ocean access).

In its 90 years of existence, over 800 000 vessels have transited the canal, carrying 6 billion tons of cargo. About 13 000 ships transit the canal every year, with an average of 35 ships each day. The canal, however, has the capacity to handle 50 ships a day. Grains account for roughly 43% of traffic, while containers and petroleum products account for 11% and 10% respectively, representing oil traffic of approximately 0.6 Mb/d. The Panama Canal Authority collects tolls on all ships that cross the canal. A loaded ship pays about US$2.57 per net ton and the average toll is about US$45 000. The introduction of super-tankers in the early 1950s forced a rethinking of its strategic importance since economies of scale in petroleum shipping are limited by the size of the canal. It is synonymous with a standard in maritime transport related to capacity, the Panamax standard, which is equivalent to 65 000 deadweight tons and a draft of 12 metres.

The canal handles close to 12% of the American international seaborne trade of the United States. Under the control of the United States until 1979, its administration was entrusted to the State of Panama by the Panama Canal Treaty of 1977. In December 1999, ownership of the canal was returned to Panama and is managed by the Panama Canal Authority. The same year, the Hong Kong port operator, Hutchison-Whampoa, leased terminals on the Atlantic (Cristobal) and Pacific (Balboa) portions of the Canal with a 25-year lease. This raised concerns within the United States government as it was perceived that control of the canal was falling into foreign interests, namely to a company perceived to be a façade for the Chinese government. There is also the issue of improvement to the rail line between the two ports to handle growing containerized traffic. This rail line is important because it offers an alternative to the size limitations of the canal, preventing large – "post-panamax"– containerships to go through. The same rationale applies to oil circulation with the trans-panama pipeline, which resumed operations in 2003. The additional capacity this pipeline provides, however, is limited to approximately 1 Mb/d. New oil development projects, namely in Ecuador and Peru, are likely to increase the importance of Panama in global oil distribution.

CONCLUSION

Growing demand and squeezed supplies are unavoidable consequences of the geography of petroleum production, distribution and consumption. The global economy is beginning to realize the full extent of a growing shortage of oil and its inherent economic and geopolitical costs. Current estimates place the peak of global oil production at around 2008-2010 (Deffeyes, 2001; Greene *et al.*, 2003). In the meantime, oil consumers are struggling to diversify their oil supplies, but most of the remaining oil reserves are predominantly in the Middle East, a region which will remain the focal point of global oil shipments. Although there is a current energy shift towards renewable and environmentally-friendly resources, such as natural gas and eventually hydrogen, the move from petroleum is likely decades away (Rifkin, 2002). Even a transition to natural gas, the reserves of which are substantial, would be very costly since entirely new distribution infrastructures would be required, including additional LNG carriers, terminals and processing facilities. Meanwhile, an era of insecurity and vulnerability is likely to prevail as petroleum circulation increases, with strategic chokepoints bearing the brunt of the tension. Like the limited additional petroleum production capacity, the circulation capacity, which is mainly dictated by the chokepoints of oil circulation, leaves little room for additional growth (table 1). These geographical constraints cannot be bypassed easily and will be a significant factor in global insecurity of oil supplies in terms of who will get preferential access to these limited resources. The situation is likely to become very tense among large consumers, such as the United States and China during the second decade of the XXIst century, as they compete, while the outlets of the Middle East handle the last large volume supply routes of the petroleum era. Clearly, solutions for petroleum distribution, namely the use of chokepoints, will require rationalized use, since additional economies of scale in maritime shipping are difficult to achieve [11] and since alternative routes, including pipelines are limited and insecure. In spite of all the challenges inherent to oil circulation, "the Spice must flow".

Table 1 Chokepoints: Capacity, Limitations and Threats

Chokepoint	Usage (ships / day, 2003)	Additional Capacity	Limitation	Threat
Hormuz	50	Limited	Narrow corridors	Iran / Terrorism
Suez	38	Some	200 000 dwt and convoy size	Terrorism
Bosphorus	135	Very limited	Ship size and length; 200 000 dwt	Restrictions by Turkey; navigation accidents
Malacca	600	Substantial	300 000 dwt	Terrorism / Piracy
Panama	35	Limited	65 000 dwt	Not significant

ACKNOWLEDGEMENT

The author would like to thank anonymous referees for helpful comments and corrections.

NOTES

1 The amount of energy used per unit of output.
2 Organization of Petroleum Exporting Countries.
3 As of 2003, the United States were extracting about 8.8 Mb/d and had an oil reserve of approximately 72 677 million barrels.
4 Millions of barrels per day (Mb/d). A barrel is the equivalent of 42 US gallons or 159 litres.
5 There have been serious issues regarding the actual availability of oil reserves, since some figures have been inflated to uphold the confidence of markets and investors. For instance the oil giant Royal Dutch/Shell acknowledged in 2004 that it had overestimated its oil and gas reserves by 22% (approximately 4.5 billion barrels).
6 As of 2002, United States strategic reserves were just under 600 million barrels, which would be enough to supply the United States economy for about a month.
7 *Very Large Crude Carriers*, which can carry up to 300 000 deadweight tons of crude oil, about 2 million barrels.
8 Tankers between 120 000 to 200 000 deadweight tons.
9 Tankers between 80 000 and 120 000 deadweight tons.
10 A group of about 230 uninhabitable islands totaling a mere 8 square kilometres.
11 Not necessarily because of ship size, but because of terminal access.

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