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Influence of global crude salt supply on soda ash

Review of international salt trade developments in Asia-Pacific region

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International Soda Ash Summit 2011, Guangzhou, China, 6.12.2011

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Flight over Australian Saltfields

GOOGLE EARTH

Recently, Salt Partners flew over some of the world largest solar saltfields. Isabella Sedivy was shooting pictures.

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Shark Bay Salt Stockpiles

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At Shark Bay, the stockpiles are 200m long and 60m wide. Their design capacity is 250’000 t. They were less than half full.

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Lake McLeod Salt Stockpile

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At Lake McLeod, the stockpile next to the wash plant has a design capacity of 1’500’000 t. It was about 12% full.

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Lake McLeod Shipping Stockpile

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The Lake McLeod shipping stockpile is designed for up to 270’000 t. The heap was holding about 7’000 t.

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Onslow Salt Stockpile

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Onslow stockpile was designed for 500‘000 t of salt. The picture shows the last salt shipment from Onslow. Therafter, there was virtually no salt left.

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Onslow Crystallisers

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The Onslow saltworks were flooded. Salt in one crystalliser was visible and was being harvested. Other crystallisers were inundated.

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Onslow Brine Pond No. 1

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Onslow brine pond one week after it was hit by cyclone Dominic. Dykes were broken through at three locations. Brine was flowing out, to the sea. It took many months to restore full production.

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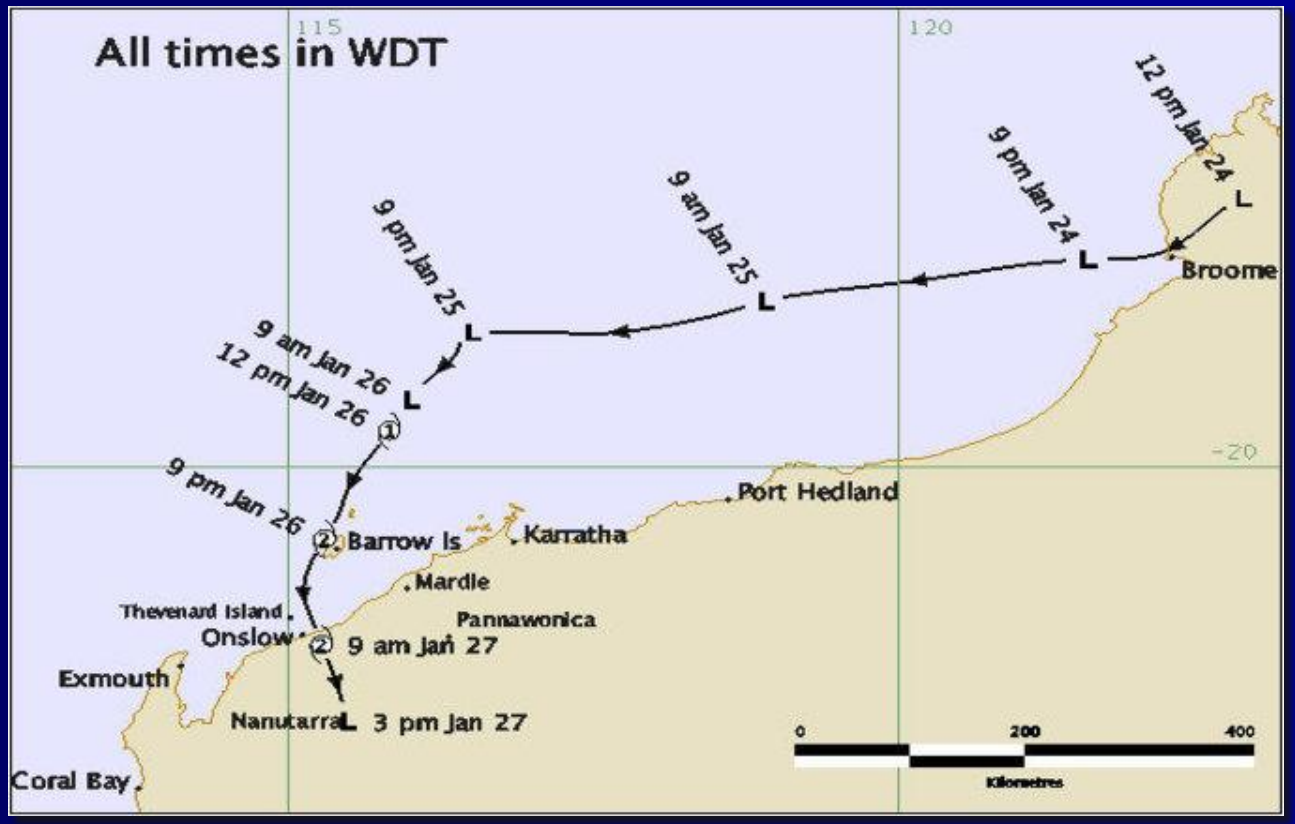
Tropical Cyclone Dominic



Australian Bureau of Meteorology

The Onslow saltfield was hit by tropical cyclone Dominic. Dominic was a moderate, category 2 cyclone with wind gust 140 km/h and 240 mm rainfall.

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Dampier Original Drying Stockpile

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At Dampier, the original drying stockpile was designed for up to 2’000’000 t. It is not being used any more. Harvested salt is hauled to the new washing plant near the sea shore.

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Dampier Original Intermediate Stockpile

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The two Dampier original intermediate stockpiles are now used to dry the salt washed in a new washing plant. They are 400 m long and 55 m wide. They can hold up to 500'000 t. The pictured stock is estimated at about 170'000 t or 36% of design capacity.

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Dampier Shipping Stockpile

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Dampier shipping stockpile could hold more than 250’000 t. The picture shows less than100’000 t of salt ready for shipment.

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Port Headland Stockpiles

Port Headland stockpiles are large enough to hold about 1’400’000 t. They were less than 60% full.

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Australian Salt Stockpiles

Salt Producer	Stockpile	Stockpile Capacity	Salt on Stock	Percent Full
		(t)	(t)	(%)
Shark Bay		275‘000	133‘000	48%
Onslow		652‘000	1‘000	0%
McLeod	Drying	1'520‘000	180‘000	12%
	Shipping	267‘000	7‘000	3%
Dampier	Drying	1'896‘000	0	0%
	Intermediate	475‘000	169‘000	36%
	Shipping	264‘000	96‘000	36%
Port Headland	Drying	999‘000	567‘000	57%
	Shipping	384‘000	199‘000	52%
Total		**6'732‘000**	**1'352'000**	**20%**

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Australian Salt Production Capacity and Design Stockpiling Capacity

Salt Producer	Production Capacity	Stockpiling Capacity	Percent
	(t/y)	(t)	(%)
Shark Bay	2’200’000	275’000	13%
Onslow	2’500’000	653’000	26%
McLeod	2’300’000	1’787’000	78%
Dampier	4’000’000	2’635’000	66%
Port Headland	3’500’000	1’384’000	40%
Total	**14’500’000**	**6’734’000**	**46%**

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Australian Salt Production Capacity and Salt on Stockpile

Salt Producer	Production Capacity	Salt on Stockpile	Percent
	(t/y)	(t)	(%)
Shark Bay	2'200'000	133'000	6%
Onslow	2'500'000	1'000	0%
McLeod	2'300'000	187'000	8%
Dampier	4'000'000	264'000	7%
Port Headland	3'500'000	765'000	2%
Total	**14'500'000**	**1'352'000**	**9%**

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Drip-off Belts

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Most Australian wash plants employ drip-off belts. This picture shows that at the end of such belt, the salt is still dripping wet.

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Salt Drying on Stockpiles

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Drip-dried salt is wet when stockpiled. The brine flows slowly to the ground and out of the stockpile (see bottom left).

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Salt on Stockpile, Humidity vs. Time

Magnesium salts are hygroscopic. They absorb moisture from the air. The brine so formed dilutes the magnesium. As long as the salt is more than 3% humid, the brine flows with the magnesium out of the stockpile. After the magnesium is removed, the salt can dry up. The drying process takes about 3 months.

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Residual Magnesium in Salt after Washing

- **Magnesium in bitterns: 2.64%**
- **Magnesium in 10% humid salt after harvest: 0.26%**
- **Magnesium in sea water: 0.14%**
- **Standard magnesium content in salt: 0.02%**

Washing with sea water	Magnesium in 10% humid salt	Magnesium in 2.5% humid salt	Salt losses by dissolution
(l/t of salt)	(%)	(%)	(%)
100	**0.139**	**0.035**	**3**
200	**0.097**	**0.024**	**7**
300	**0.076**	**0.019**	**10**

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Consequences of Insufficient Salt Stock on Stockpile

- Insufficient reserve to overcome temporary production shortage
- Excessive humidity and magnesium, salt not up to specification
- Higher wash water consumption, thus excessive salt losses
- Reduced production rate

Insufficient Salt Stock is Undesirable

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Salt Production World-wide

Salt type	World production
Solar salt	100,000,000 t/y
Rock salt	80,000,000 t/y
Brines	80,000,000 t/y
Total	260,000,000 t/y

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Salt Consumption World-wide

Salt user	Salt consumption
Chemical industry	155,000,000 t/y
Food	45,000,000 t/y
De-icing	30,000,000 t/y
Other	30,000,000 t/y
Total	260,000,000 t/y

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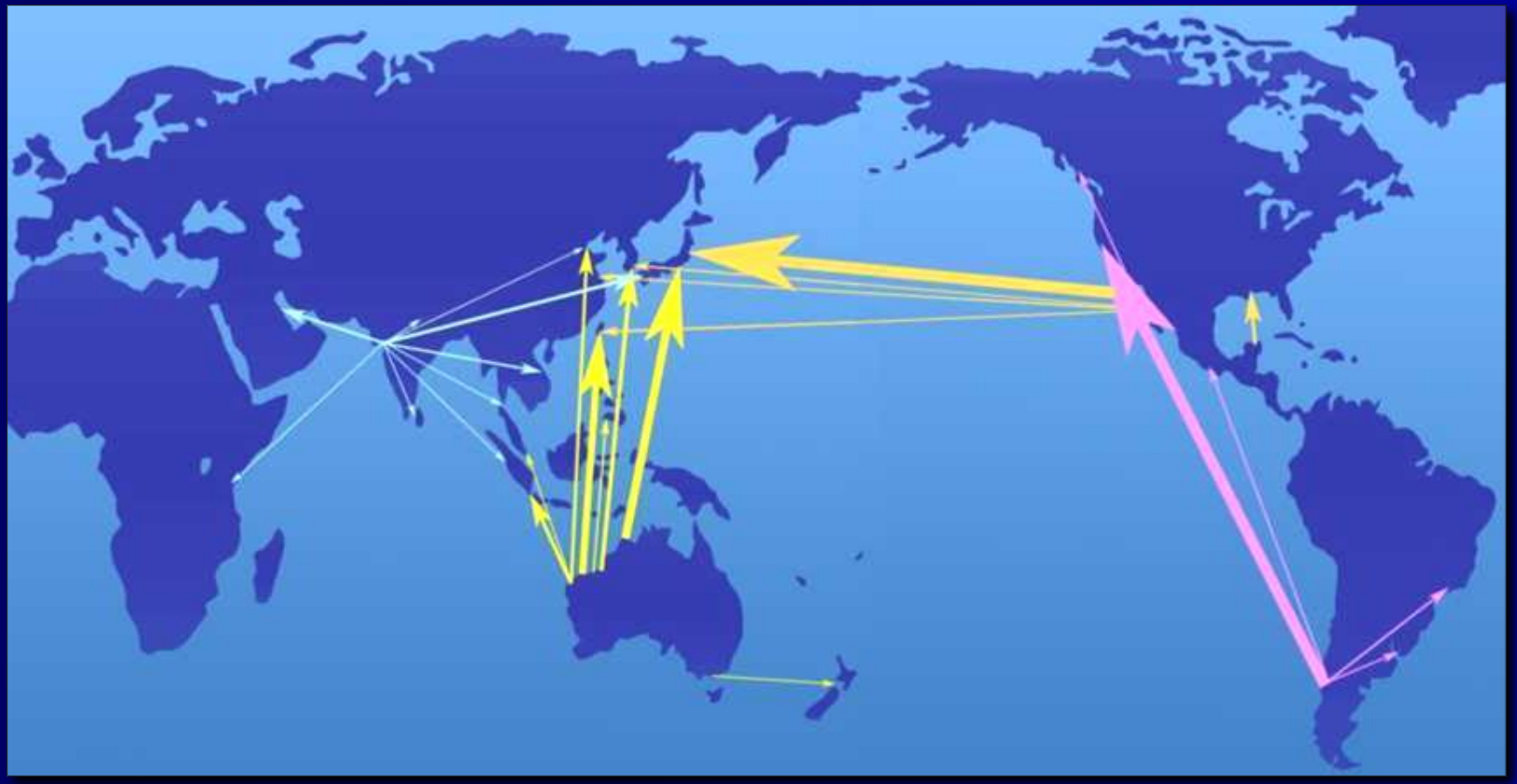
Bulk Salt Trade in Asia-Pacific



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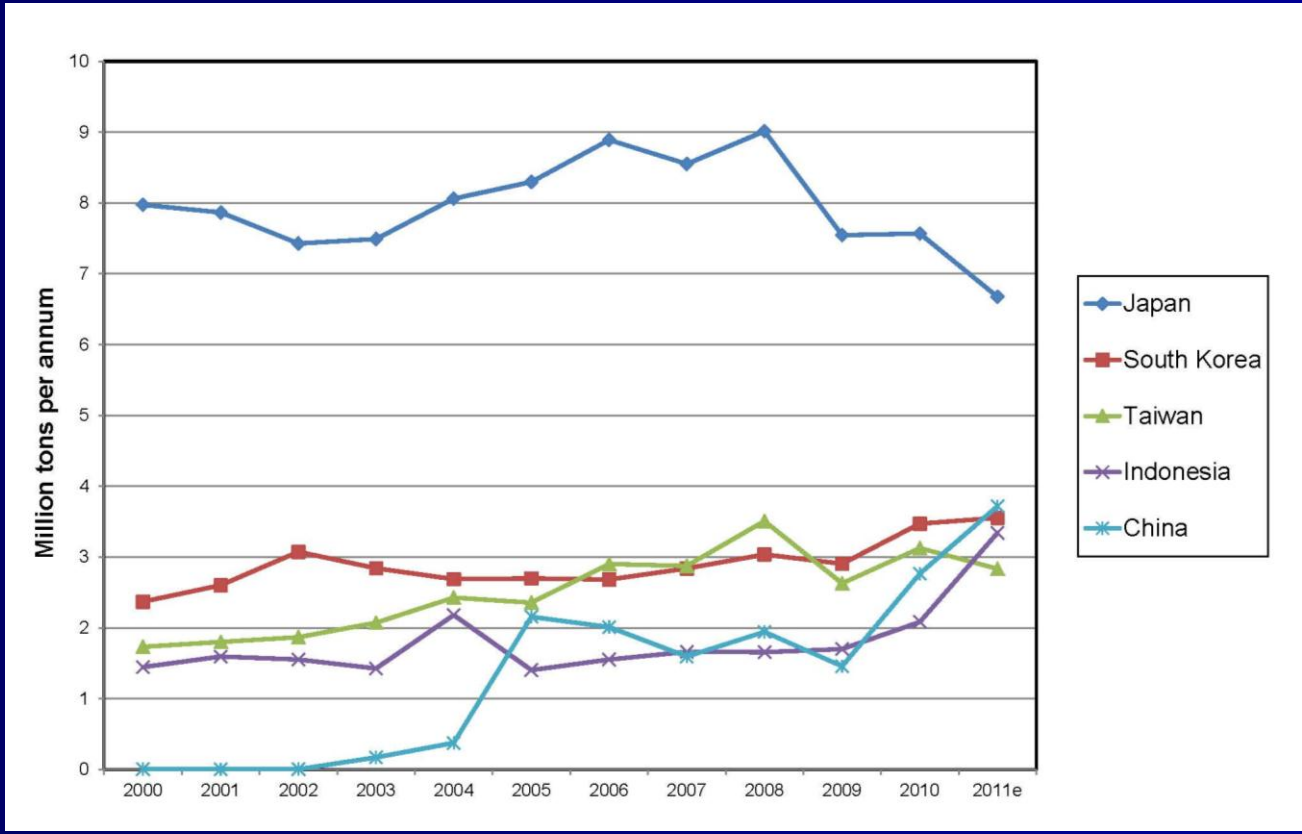
Largest Salt Imports in Asia-Pacific



Salt imports of the five largest salt importers in Asia Pacific region. Since 2000, these countries have increased their salt imports by average 3.7% per annum.

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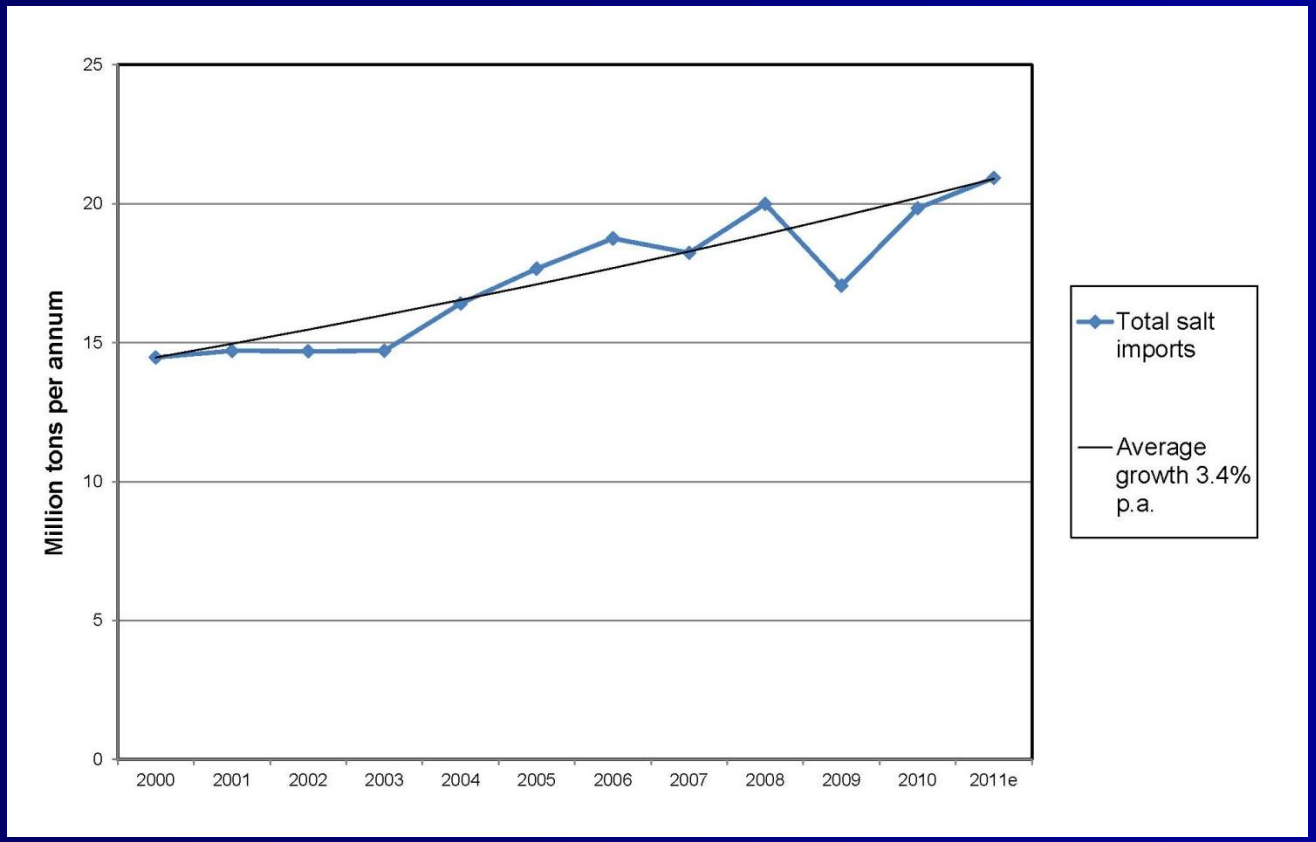
Total Salt Imports in Asia-Pacific



Since 2000, salt imports of 11 largest salt importers in Asia Pacific region have risen by 6.5 million tonnes, equal to 45%, or equal to 3.4% per annum.

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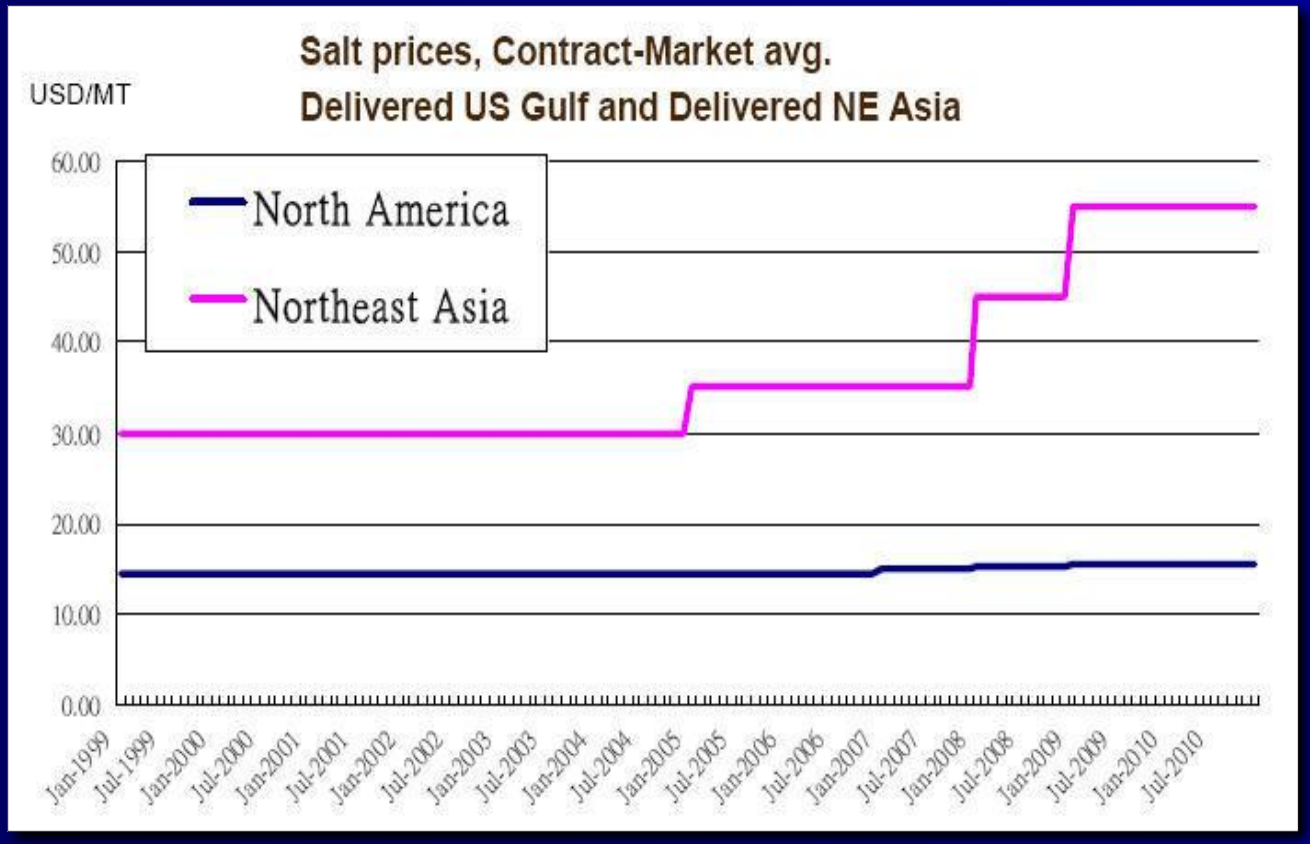
Salt Prices in US Gulf and North East Asia



Since 2005, salt prices delivered in North East Asia-Pacific region have risen by USD 25 per ton, equal to 83%, or equal to 16% per annum.

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Salt Prices in North East Asia

USD/MT

		2006	2007	2008
JAPAN	Import	40	43	47
KOREA		40	43	46
CHINA		35	34	41
CHINA	Local	30	33	57

GTA

Since 2006, salt imports to Japan, Korea and China have risen by USD 6 - 7 per ton. In the meantime, the local salt prices in China have risen by USD 27 per ton.

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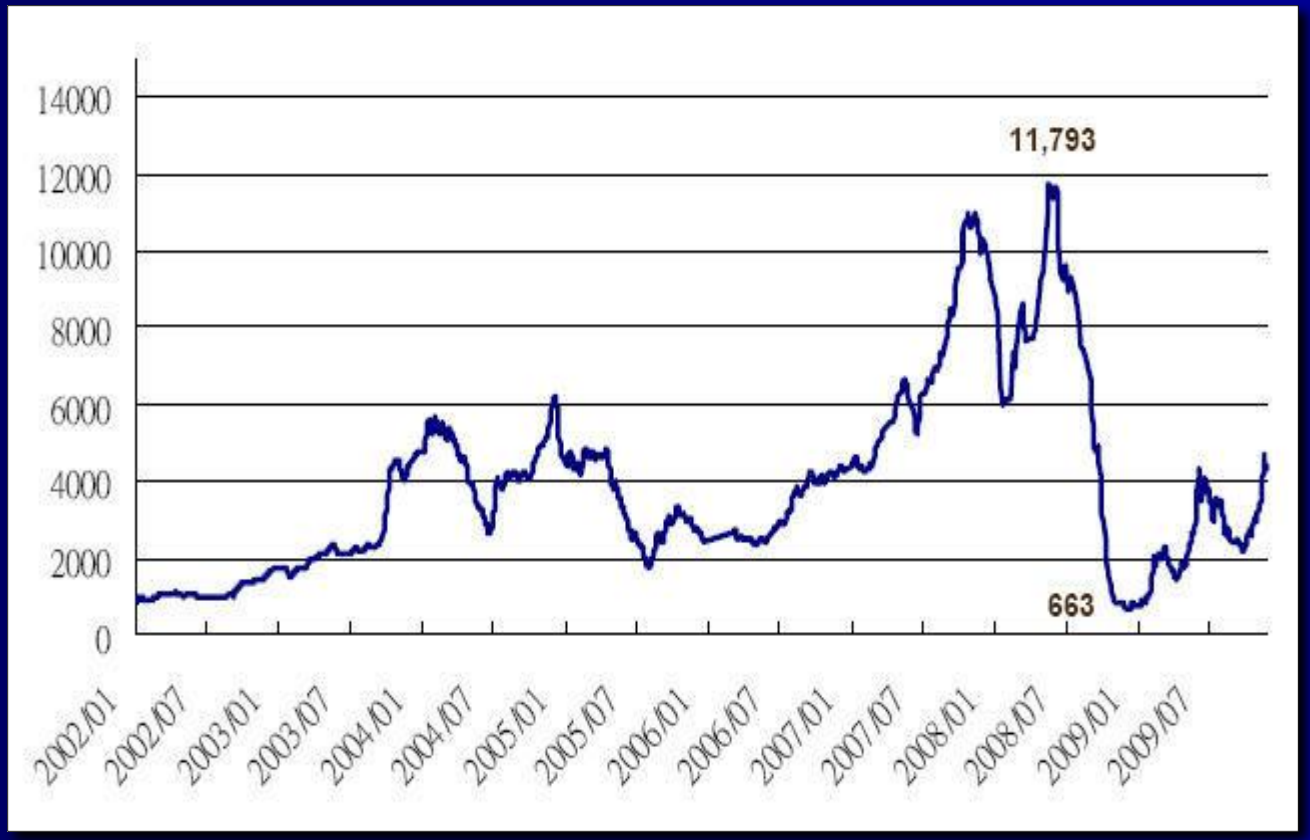
Ocean Freight Cost Development since 2002



Since 2002, ocean freight cost measured by the Baltic Dry Index rose from 1000 to almost 12'000 in 2008, dropped to less than 700 and rose to it's long term trend average of approx. 2'000 at present.

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Ocean Freight and Salt Price Development

GTA

Since 2002, delivered salt prices to North East Asia have been rising independently of the high ocean freight cost fluctuations.

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Salt Supply Situation in other Regions

- Indian salt quality is not up to the “Australian standard”
- Due to shortage, Indian salt prices moved from INR 200/t to 800/t
- In the south of Africa, salt stockpiles are depleted
- Mexican salt production is at maximum and unlikely to expand
- Chilean salt has limited potential for the chloralkali industry
- Brazil is too far away from Asia-Pacific region

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Conclusion

Insufficient salt on stockpiles in Australia, together with signs of limited salt availability elsewhere, indicates that the present high quality solar salt production capacity is insufficient. The shortage is likely to accentuate when the present economic slowdown comes to an end and the high growth rates in the Asia-Pacific region are re-established.

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Remedy Option No.1:

Compensate shortage with poor quality salt

This option is undesirable:

- **Impurities increase the cost of brine treatment in chloralkali plants**
- **Poor quality salts cause excessive contaminated effluent discharge**

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General Cost of Salt and Impurity Removal

	Cost of brine treatment and sludge disposal in caustic / chlorine plants	Cost of salt, brine treatment and sludge disposal
	(USD / t salt)	(USD / t salt)
Minimum	**1.50**	**10**
Average	**10**	**25**
Maximum	**30**	**50**

SALT PARTNERS AT GANDHIDHAM 2008 SALT CONFERENCE

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Remedy Option No. 2

Compensate shortage with vacuum salt

This option is undesirable:

- **Vacuum salt is expensive**
- **Vacuum salt production is mostly energy inefficient**
- **1 ton of CO_2 per ton of salt may emanate when burning black coal**
- **Burning black coal frequently causes pollution**
- **CO_2 in the atmosphere causes global warming and climatic change**

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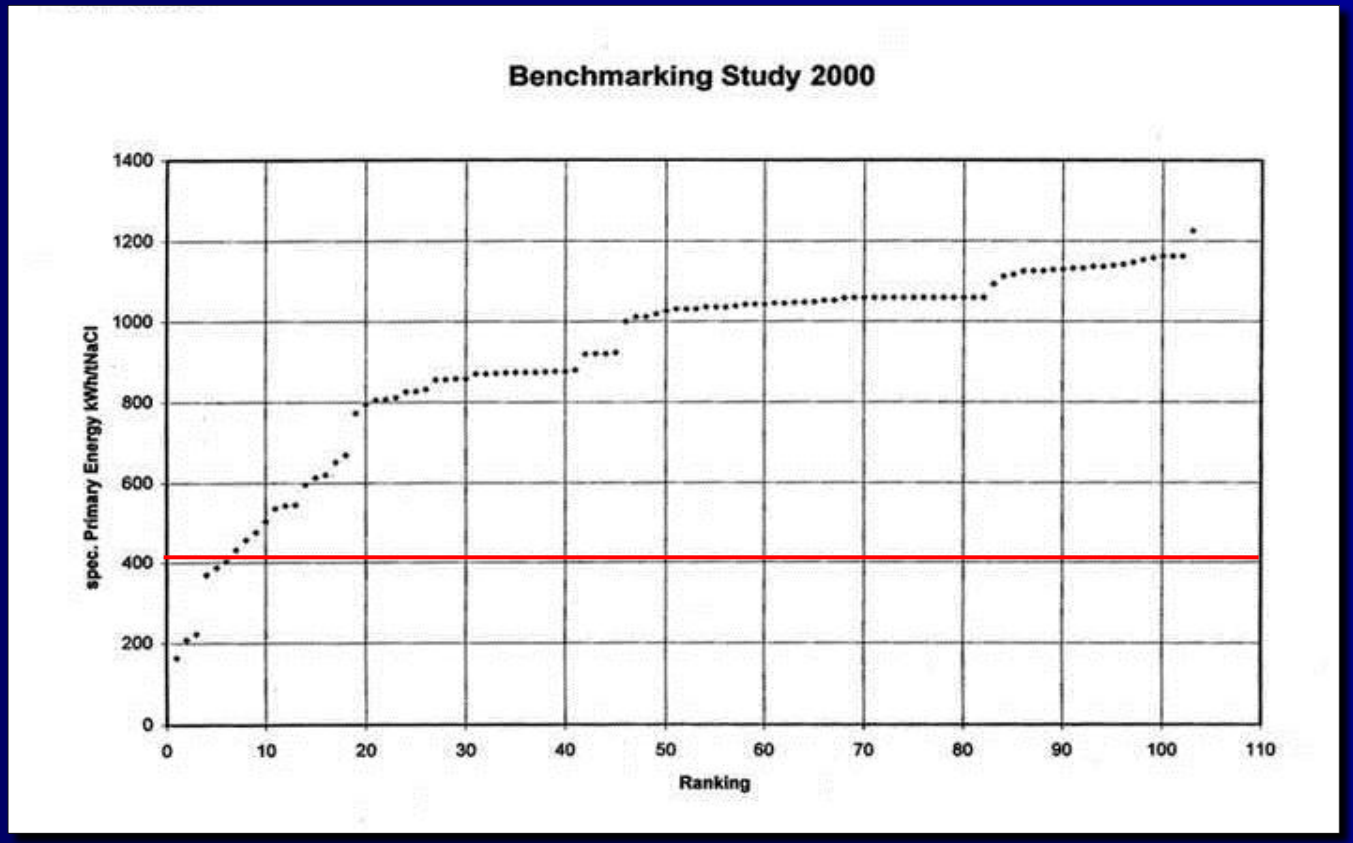
Energy Consumption Benchmarking Study



96 out of 103 thermal salt evaporating plants use more than theoretical amount of energy.

EVATHERM

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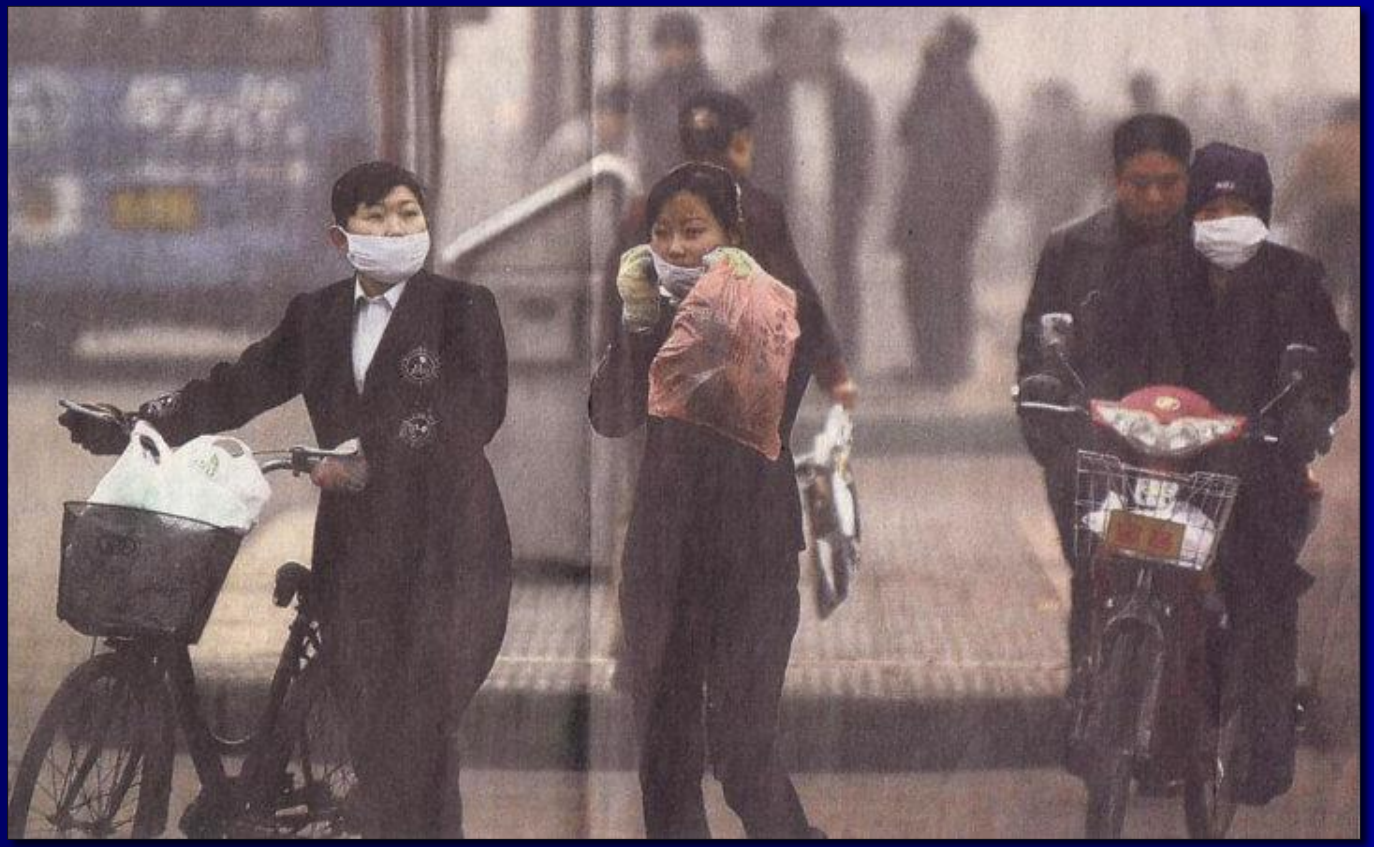
Air Pollution



WU HONG / EPA

In China, black coal is burned to make steam for vacuum salt production.

International Soda Ash Summit 2011, Guangzhou, China, 6.12.2011

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Global Warming

NASA

Hurricane "Katrina" in the Gulf of Mexico on 29.8.2005.

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Destructive Climatic Change

Groenteman

Hurricane “Katrina” destroyed large parts of New Orleans and surroundings. Increased hurricane activity is believed to be caused by global warming.

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Remedy Option No. 3

Compensate shortage with additional high quality solar salt production capacities

This option is highly desirable:

- **High quality solar salt is inexpensive**
- **Solar salt production employs renewable energy most effectively**
- **Solar saltfields are environmentally beneficial wetlands**

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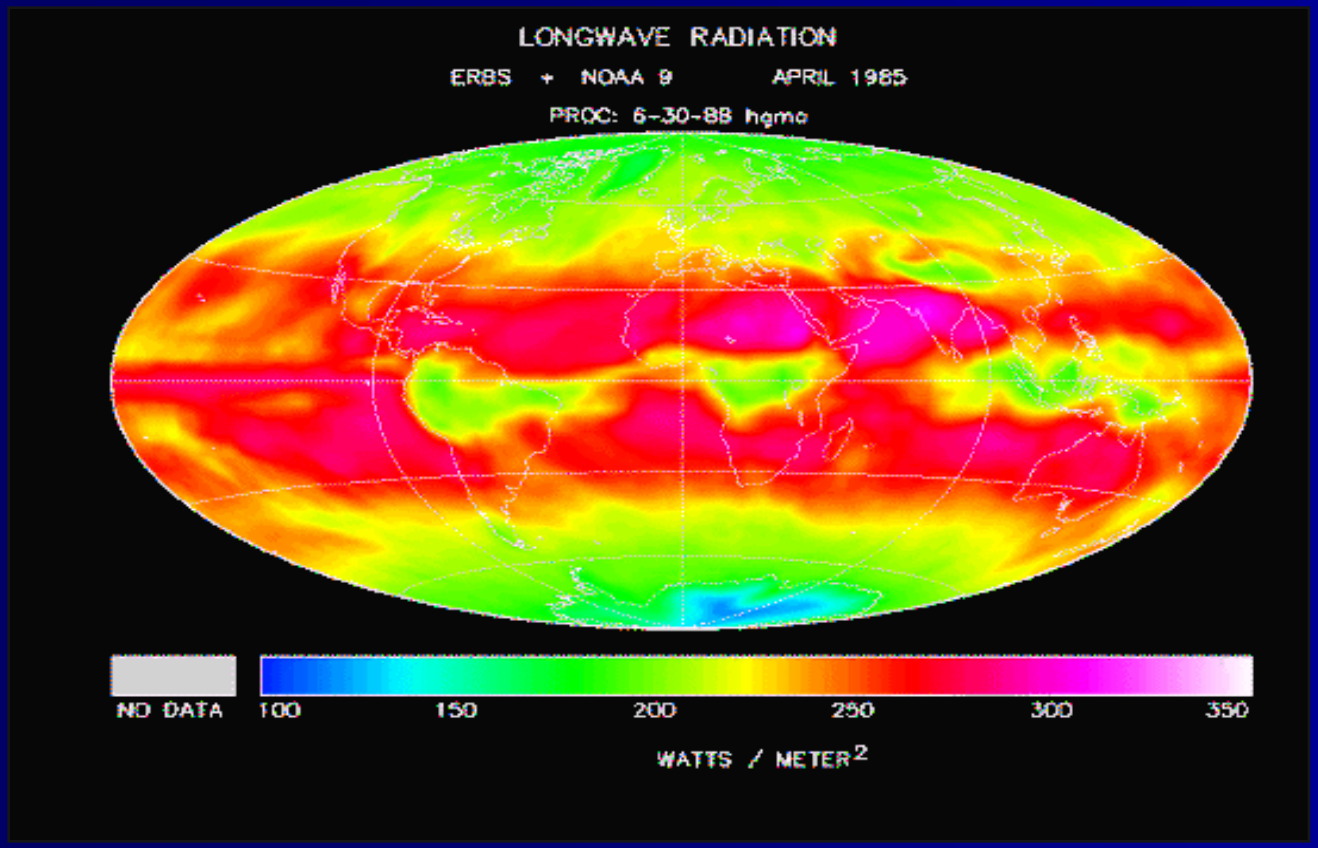
Solar Energy on the Planet Earth



NASA

Locations with highest rates of evaporation, suitable for solar salt production:

Caribbean Sea
North Africa
South Africa
Middle East
Western India
Western Australia

In China, the Gulf of Bohai receives only half the solar energy available at the most suitable locations.

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Chinese Solar Salt Production Method

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At the Gulf of Bohai, sudden rain storms are frequent and heavy. Saturated brine is being protected against dilution with plastic foils. The plastic is pulled over the brine, rain water is drained when the storm is over and the plastic foil is rolled back using electric motors.

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Chinese Salt Production Method is Labour Intensive

Large workforce is required to live inside the saltworks to pull the plastic quickly, within an hour of the storm warning and drain the rain water when the storm is over. How long will the workforce be available at the present low cost?

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Australian and Chinese Saltworks Productivity

Salt Producer	Production Capacity	Saltworks Area	Productivity
	(t/y)	(km2)	(t/km2)
Shark Bay	2'200'000	70	31'400
Onslow	2'500'000	86	29'000
Dampier	4'000'000	100	40'000
Port Headland	3'500'000	92	38'300
Hangu Changlu	1'000'000	135	7'400

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Solar Salt Production in the North of Bohai Gulf

Two major Tianjin saltworks occupy approx. 400 km2 of land adjacent to the booming TEDA (Tanggu Economic Development Area).

To the north of TEDA, the Hangu Changlu Saltern produces 1’000’000 t/y of solar salt on135 km2 of land.

In the middle, one of the largest Chinese ports is being developed.

Saltworks land in the south of TEDA, next to the harbour, has already been converted to a coal storage (see the black spot).

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Conversion of Solar Saltworks to Industrial Parks

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Parts of the Hangu Changlu Saltern have already been converted to an industrial park.

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Conclusion

Solar salt production in the Gulf of Bohai has a limited future potential:

- **Present production method is too labour intensive**
- **Climatic conditions are unfavourable**
- **Land is required for more productive use**

High quality solar salt should be produced in more suitable regions more efficiently and imported to China.

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Opportunity for Solar Salt Exports

Solar salt exports could fill the gap if:

- Quality according to the "Australian standard", i.e. less than 0.04% Ca, 0.02% Mg and 0.12% SO4 would consistently be achieved
- Shipments in Panamax vessels would be possible
- Ship loading rates of 2'000 t/h would be facilitated

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Salt Partners Prospect New Solar Saltfields

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Salt Partners assist their clients to prospect sites where new solar saltfields could be established.

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Salt Partners supply technologies for production of salt according to "Australian standard"

Modern industrial salt upgrading plant in Spain. Capacity 700 t/h solar salt

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India International Salt Summit, Ahmedabad

International Soda Ash Summit 2011,
Guangzhou, China, 6.12.2011

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Why not turn your salt into gold?

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