



第一堂課－企業防災思維

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E·R·M
Eos Rhea Metis, Ltd.



首席總監

ERM

學歷 EDUCATION

- 美國科羅拉多大學 博士 Ph.D. University of Colorado at Boulder, U.S.A.
- 美國密西根大學 碩士 M.S. University of Michigan, U.S.A.
- 台灣大學 學士 B.S. National Taiwan University, Taiwan

專業 EXPERTISE

- 風險管理與風險評估 Risk Management and Risk Engineering
- 土木/環境/海域工程 Civil/Environmental/Offshore Engineering

專業資格 CERTIFICATION

- 美國加州註冊土木工程師 (No. C 61731) Registered Professional Engineer, CA, U.S.A.
- 國際價值協會副價值專家 (201212302) Certified Associate Value Specialist, SAVE International

專業會籍 AFFILIATIONS

- 臺灣防災產業協會理事兼保險暨企業風險管理委員會主任委員
- 臺灣防災教育訓練學會理事
- 中國土木水利工程學會兩岸交流委員會委員
- 中國銀行保險公司海外項目風險管理戰略合作專家
- 中國人民財產保險股份有限公司風險管理特約專家

經歷 EXPERIENCE

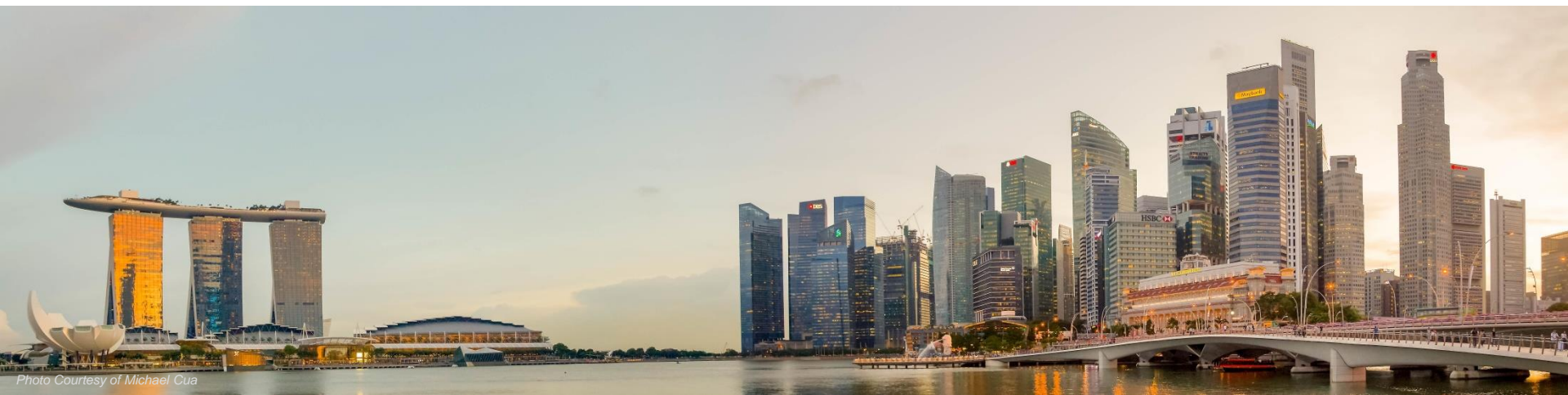
- Eos Rhea Metis, Ltd., 台北 (現任)
- 桃園大眾捷運股份有限公司, 桃園
- 逢甲大學, 台中
- 環興科技股份有限公司, 台北
- 慕尼黑再保險公司北京分公司, 北京
- 廣鎂工程顧問有限公司, 台北
- 亞新工程顧問股份有限公司, 台北
- Engineering Consulting Services, Ltd., Buffalo Grove, IL, U.S.A.
- Fugro West, Inc., Ventura, CA, U.S.A.
- NTH Consultants, Ltd., Farmington Hills, MI, U.S.A.
- 台北市政府捷運工程局, 台北

著作 PUBLICATIONS

40餘件專業論文及書冊

Agenda

1. 前言
Prelude
2. 自然災害
Natural Hazards
3. 人為災害與風險複合
Anthropogenic Hazards and Risk Convolution
4. 結論
Conclusion
5. 問答
Q & A



前言
PRELUDE



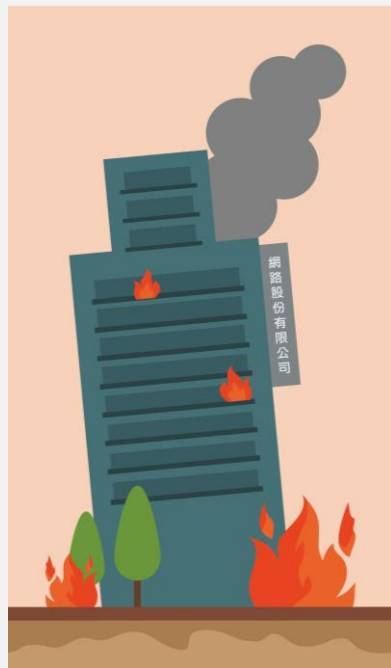
《災害防救法》的災害定義

□ 我國《災害防救法》第2條將「災害」做了定義。
所謂的「災害」，係指下列災難所造成的禍害：

- 風災、水災、震災（含土壤液化）、旱災、寒害、土石流災害等天然災害。
- 火災、爆炸、公用氣體與油料管線、輸電線路災害、礦災、空難、海難、陸上交通事故、森林火災、毒性化學物質災害、生物病原災害、動植物疫災、輻射災害、工業管線災害等災害。



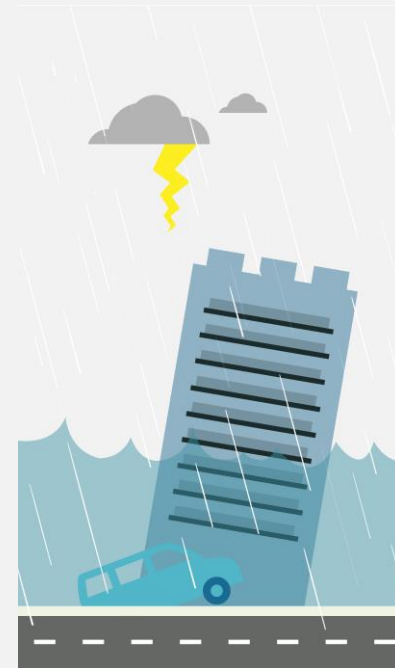
台灣常見的自然災害



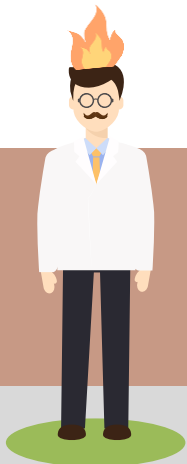
火災爆炸



地震液化



颱風淹水



企業經營重大災害案例

921大地震

1999 · 工業區的企業廠房全毀。

泰國水災

2011 · 國外廠房泡水，供應鏈中斷。

日本311強震

2011 · 關東地區停電，影響企業營運甚鉅。

高雄氣爆事故

2014 · 地下管線中斷，造成相關企業損失。

八仙粉塵爆燃

2015 · 新北政府勒令八仙樂園無限期停業。

年分	發生地點	業別	爆炸原因
85	工廠	塗料廠	化學物品製程不慎引火
86	工廠	金屬公司	工廠鋁熔爐爆炸
87	公司	瓦斯公司	瓦斯外洩導致爆炸
90	工廠	生化公司	機械設備不明原因爆炸
92	工廠	爆竹工廠	不明
94	工廠	化學工廠	不明
96	鐵皮工廠	非法私設工廠	非法加工爆竹不慎爆炸
97	鐵皮屋	非法私設工廠	非法加工爆竹不慎爆炸
99	鐵皮屋	瓦斯公司	私設倉庫瓦斯爆炸
100	工廠	爆竹工廠	作業失誤
100	工廠	科技公司	卡車溫度過高，有機溶劑燃燒
101	工廠	壓鑄工司	化學物品洩露
102	儲存場所	化學原料公司	化學物品著火
103	儲存場所	化學公司	施工焊接不慎，接觸可燃氣體
104	儲存場所	石化工廠	電器因素

自然災害
NATURAL HAZARD –

2011年泰國洪水
2011 THAILAND FLOOD

事件統計資料

- 時間: 8/1 – 11/15 2011
- 房屋毀損: 19,000
- 死亡人數: 813
- 總體經濟損失: USD\$ 46.5 Billions (World Bank)
- 製造業損失: USD\$ 32 Billions (泰國政府統計)
- 保險損失: USD\$ 10 Billions (Munich Re)

洪水發生原因

- 多月連續強降雨 Continuous torrential rain
- 地勢平坦及地層下陷 Ground subsidence
- 都市開發不當 Poor urban development
- 水資源管理不當 Poor water management

災害發生原因

- 災害管理不當 Poor Disaster Management
- 洪澇管理不良 Poor Flood Management
- 缺乏風險溝通 Poor Risk Communication
- 防洪設施故障 Malfunctioned Flood Protection Facilities

工業區企業受影響情形

Impact in Industrial Parks



Industrial Park or Estate	Province	Number of companies (number of Japanese companies)	Inundated date	Date completed draining water	Time to finish drainage (days)
Saha Ratta Nanakorn Industrial Estate	Ayutthaya	42 (35)	Oct. 4, 2011	Dec. 4, 2011	62
Rojana Industrial Park	Ayutthaya	218 (147)	Oct. 9, 2011	Nov. 28, 2011	51
Hi-Tech Industrial Estate	Ayutthaya	143 (about 100)	Oct. 13, 2011	Nov. 25, 2011	44
Bang Pa-in Industrial Estate	Ayutthaya	84 (30)	Oct. 14, 2011	Nov. 17, 2011	35
Nava Nakorn Industrial Estate	Pathum Thani	190 (104)	Oct. 17, 2011	Dec. 8, 2011	53
Bankadi Industrial Park	Pathum Thani	34 (28)	Oct. 20, 2011	Dec. 4, 2011	46
Factory Land (Wangnoi) Industrial Park	Ayutthaya	93 (7)	Oct. 15, 2011	Nov. 16, 2011	33
Total		804 (451)			

統計至2012年6月1日

Industrial park or estate	Number of factories	Operation has restored			Operation has not restored yet	Businesses has closed		
		Fully Restored	Partly Restored	%				
Saha Ratta Nanakorn Industrial Estate	46	14	13	59	14	30%	5	11%
Rojana Industrial Park	213	69	85	72	30	14%	29	14%
Hi-Tech Industrial Estate	143	75	27	71	25	17%	16	11%
Bang Pa-in Industrial Estate	90	46	31	86	12	13%	1	1%
Nava Nakorn Industrial Estate	227	55	107	71	57	25%	8	4%
Bankadi Industrial Park	36	7	17	67	9	25%	3	8%
Factory Land (Wangnoi) Industrial Park	84	70	14	100	0	0%	0	0%

Source: Haraguchi M, Lall U., Flood risks and impacts: A case study of Thailand's floods in 2011 and research questions for supply chain decision making, *International Journal of Disaster Risk Reduction* (2015)

Automobile Sectors

- Assembly Factories
- Parts
 - ICs
 - System LSIs for audio and navigation
 - Condensers
 - transistors
- Affected Companies
 - Toyota
 - Honda
 - Nissan
 - Ford

Electronics Sectors

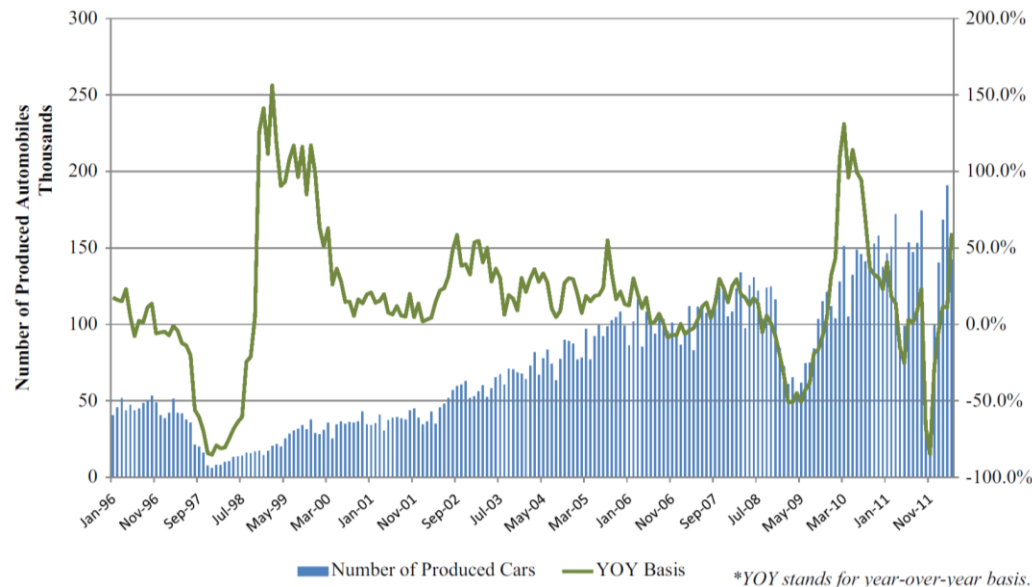
- Digital Cameras
- HDD
- Printer Parts
- Affected Companies
 - Western Digital
 - Sony
 - Nikon
 - Canon
 - Nidec
 - TDK
 - Hitachi
 - Toshiba

Transportation Sectors

- Infrastructures
 - Ground
 - Air
- Vehicles
 - Trains
 - Trucks/Cars
 - Airplanes
- Facilities
 - Power
 - Fuel
 - Logistic – warehouses

主要影響

- 日系車廠相關企業占泰國汽車相關產品生產及出口約九成，洪災影響損失較大。
- 泰國汽車廠組裝後輸出國外，廠址以近港口以降低運輸成本為選擇重要考量。泰國近港處地區較平坦且地勢低，故較易發生淹水事件。
- 受洪災影響的日系車廠主要為Toyota, Honda, 及Nissan三家公司。
- 雖然在泰國的汽車業主要是組裝工廠及零配件生產工廠，但是透過全球供應鏈，仍對全球汽車市場有重大的影響。
- 生產中斷對於汽車的銷售的影響有滯後性。

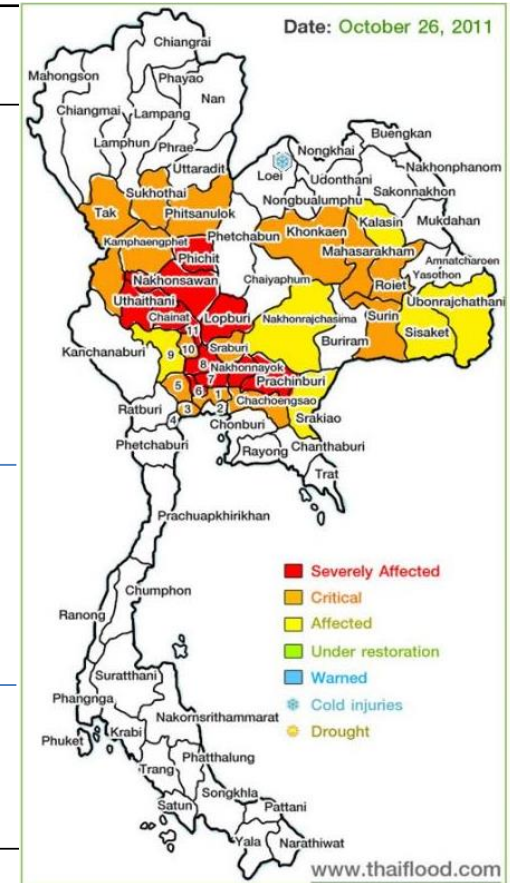


日系車廠的影響

Impact on Japanese Automobile Companies

Factory	Place	Damage	Starting date for adjusted/stopped production	Date when production is resumed	TTR (days)
Honda Honda Automobile	Rojana Industrial Park	Factory was Inundated on Oct 8th 2011, and stopped the production.	Stopped production since 10/4/2011	3/26/2012 (Partly resumed)	174
Honda Thailand Manufacturing Company Ltd	Bangkok	No inundation of factory. Stopped production due to the lack of parts supply.	Stopped production since 10/6/2011	11/14/2012 (Partly resumed)	40
Honda Suzuka Factory	Japan	Adjusted production due to the lack of parts supply.	Adjusted production since 11/7/2011	12/5/2011 (Normal level of production)	28
Honda Saitama Factory	Japan	Adjusted production due to the lack of parts supply.	Adjusted production since 11/17/2011	12/5/2011 (Normal level of production)	18
Honda 6 Factories in the north America	North America	Adjusted production due to the lack of parts supply.	Adjusted production since 11/2/2011	12/11/2011 (Normal level of production)	30
Honda Malaysia	Malaysia	Stopped production due to the lack of parts supply.	Stopped production 10/25/2011	not available	Not available
Toyota Toyota Motor Thailand Ltd, Samrong Assembly	Samut prakan Province, Thailand	No inundation of factories. Stopped production due to the lack of parts supply.	Stopped Production since 10/10/2012	11/21/2011 (Partly resumed)	42
Toyota Toyota Motor Thailand Ltd, Gateway Assembly	Chachoengsao Province	No inundation of factories. Stopped production due to the lack of parts supply.	Stopped Production since 10/10/2013	11/21/2011 (Partly resumed)	42
Toyota Toyota Motor Thailand Ltd, Baan Poe Assembly Plant	Chachoengsao Province	No inundation of factories. Stopped production due to the lack of parts supply.	Stopped Production since 10/10/2014	11/21/2011 (Partly resumed)	42
Nissan Nissan Thailand, HQ Assembly Plant	Samut Prakan Province	No inundation of factories. Stopped production due to the lack of parts supply.	Stopped production since 10/17/2012	11/14/2011 (Partly Resumed)	29
Nissan Siam Motors and Nissan HQ Assembly Plant	Samut Prakan Province	No inundation of factories. Stopped production due to the lack of parts supply.	Stopped Production Since 10/17/2012	11/14/2011	not available

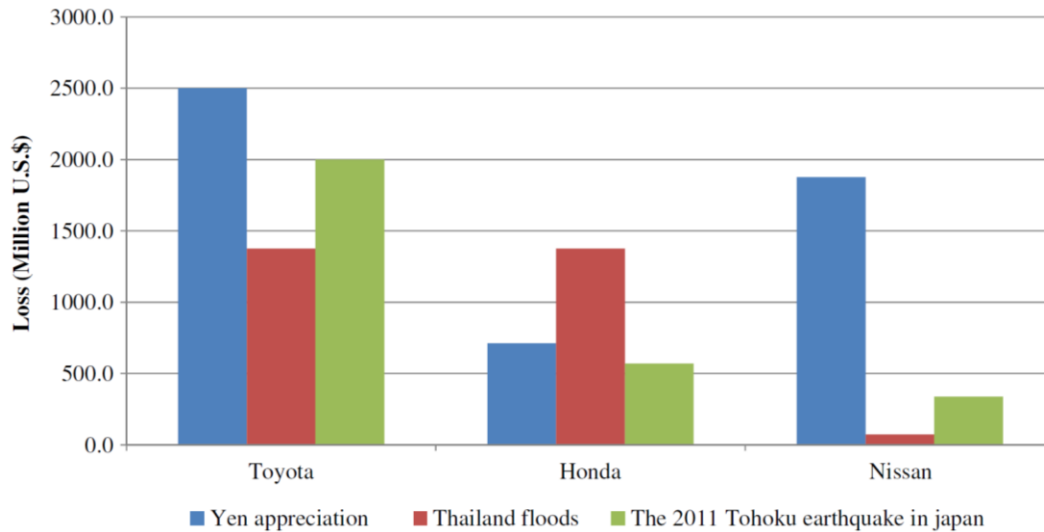
Source: Haraguchi M, Lall U., Flood risks and impacts: A case study of Thailand's floods in 2011 and research questions for supply chain decision making, *International Journal of Disaster Risk Reduction* (2015)



- Honda於Rojana Industrial Park的組裝廠2011/10/4停工，10/8淹水，廠區在水災最嚴重省分。
- Toyota及Nissan的廠區在較嚴重影響省分但並未淹水，然因組裝零件生產工廠及運輸受水災影響導致供應鏈中斷必須停產。
- Honda復原時間(TTR)最長為174天，Toyota為42天，Nissan最短為29天。

汽車業的啟示

Lesson Learned from Automobile Industry



Statistics	Toyota	Honda	Nissan
Number of lost cars at global due to Thailand floods (thousand cars)	240	150	33
Operating profit (billion yen)	270 (\$3.4B) ^a	200 (\$2.5B)	510 (\$6.4B)
Lost operating profit due to Thailand floods (billion yen)	100 (\$1.25B)	110 (\$1.4B)	5.9 (\$0.07B)
Percentage of loss of operating profit caused by Thailand flood to operating profit	37.04%	55.00%	1.16%
Operating Profit (% compared to 2020)	-42.30%	-64.90%	-4.70%
Net profit (billion yen)	200 (\$2.5B)	215 (\$2.7B)	290 (\$3.6)
Net profit (% compared to 2010)	-57.50%	-59.70%	-9%

Source: Haraguchi M, Lall U., Flood risks and impacts: A case study of Thailand's floods in 2011 and research questions for supply chain decision making, *International Journal of Disaster Risk Reduction* (2015)

重要啟示

- **Honda**的廠址位置是其損失的根原(Root Cause)，投資並非只有財務的風險。
- **Nissan**分散供應來源並將採購全球化，加上有較大的庫存量降低供應鏈中斷的衝擊。
- **Toyota**的廠區並未淹水，但由於供應鏈中斷影響所造成的損失幾乎等同廠區淹水的**Honda**。

最後贏家是影響最低、復原最快、產能影響小並能維持品質的企業

- 風險管理(事前): 避免危害及減少影響(機率與後果)
- 緊急應變管理(事中): 降低影響的程度並考慮復原作業的重點
- 營運持續管理(事後): 減少復原的時間及維持產能與品質

Company	Place of factories	Damage	State of operation /production
Western Digital	1) Bang Pa-in Industrial Estate	Factories were inundated (2 m)	- Stopped production since Oct 16, 2011 - Partly restored on Nov 30, 2011 - Needed days to restore: 46 days
	2) Nava Nakorn Industrial Estate		
Toshiba	Nava Nakorn Industrial Estate	Factory was inundated (1 m)	- Stopped production since Oct 11, 2011 - Alternate production in Philippines - Partly restored Thai factory on Feb 1, 2012 - Needed days to restore: 114 days
Seagate Technology	1) Seagate Teparuk, Amphur Muang, Samutprakarn Province	Factories were not inundated	- Some adjusted production due to the lack of supply from suppliers
	2) Seagate Korat, Amphur Sungnoen, Nakhon-Ratchasima		
Samsung	In South Korea	Factories were not inundated	- Some adjusted production due to the lack of supply from suppliers

Source: Haraguchi M, Lall U., Flood risks and impacts: A case study of Thailand's floods in 2011 and research questions for supply chain decision making, *International Journal of Disaster Risk Reduction* (2015)

重點影響

- 水災前全世界47%的硬碟(HDD)在泰國生產。
- 水災時WD因為廠房淹水(2m)，損失45%的HDD輸出量。
- Seagate及Samsung廠房雖未淹水，但是因為生產所需零件之供應商受淹水影響致供應中斷，必須調整生產線。

電子業的影響 – 以硬碟記憶體為例

Impact to IC Industry – HDD and SD

REUTERS EDITION: U.S. SIGN IN

HOME BUSINESS MARKETS WORLD POLITICS TECH OPINION BREAKINGVIEW

UCLA – NUS EXECUTIVE M
RANKED #4 in the World Financial Times Executive MBA Rankings

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ALL REVIEWS ▼ LAPTOPS / TABLETS / PHONES / APPS / SOFTWARE / SERVICES

Amazon.com

FRYE Women's Veronica Short ...
\$267.50

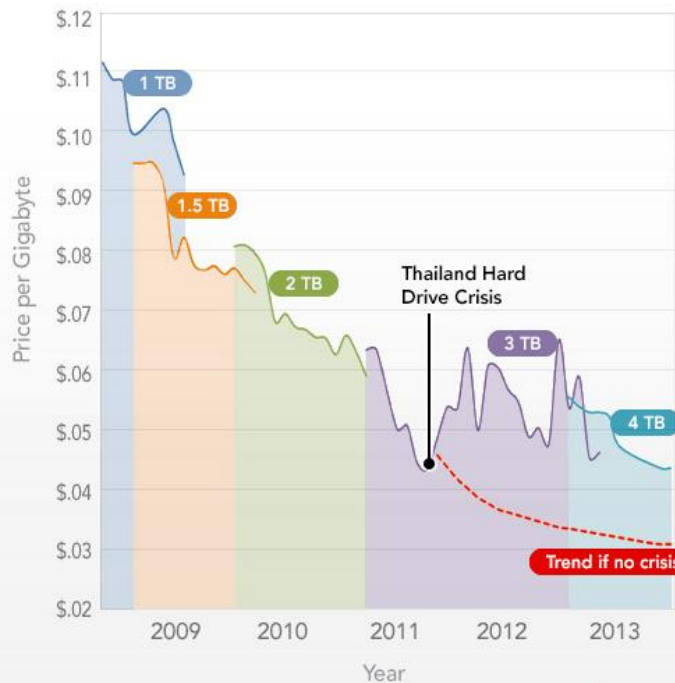
FRYE Women's ...
\$205.42 - \$298.00

Thai floods boost PC hard drive prices

BY NOEL RANDEWICH
 SAN FRANCISCO Fri Oct 28, 2011 5:49pm EDT

Cost per GB for Hard Drives

Prices Backblaze paid for drives from 2009-2013

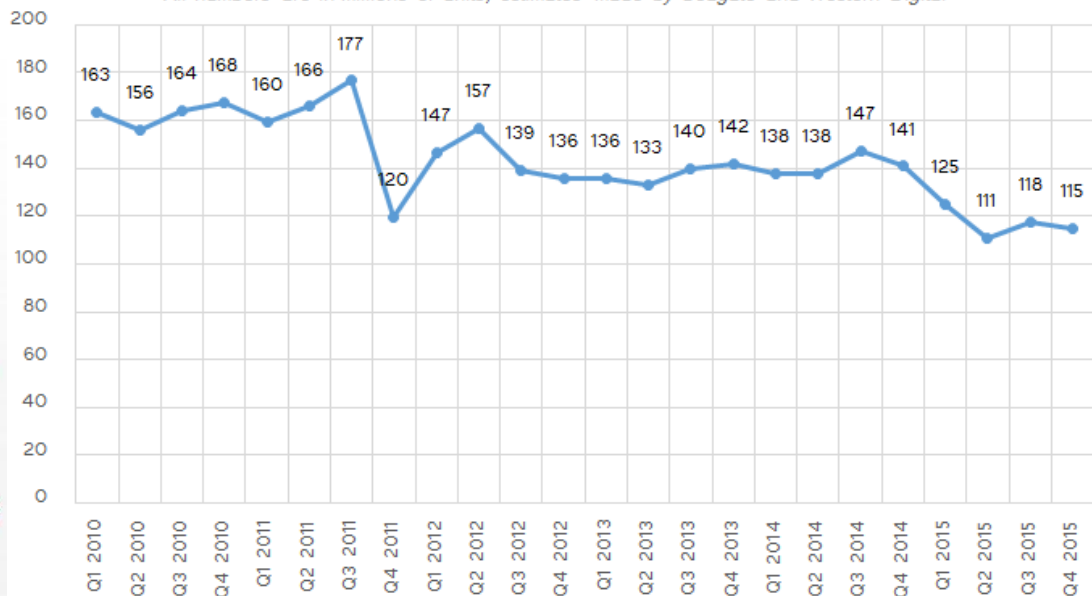


Home / Reviews / Storage Devices / Hard Drives / **Hard Drive Prices Soar 28 Percent After Thai Floods**

Hard Drive Prices Soar 28 Percent After Thai Floods

Total Available Market of Hard Disk Drives

All numbers are in millions of units, estimates made by Seagate and Western Digital

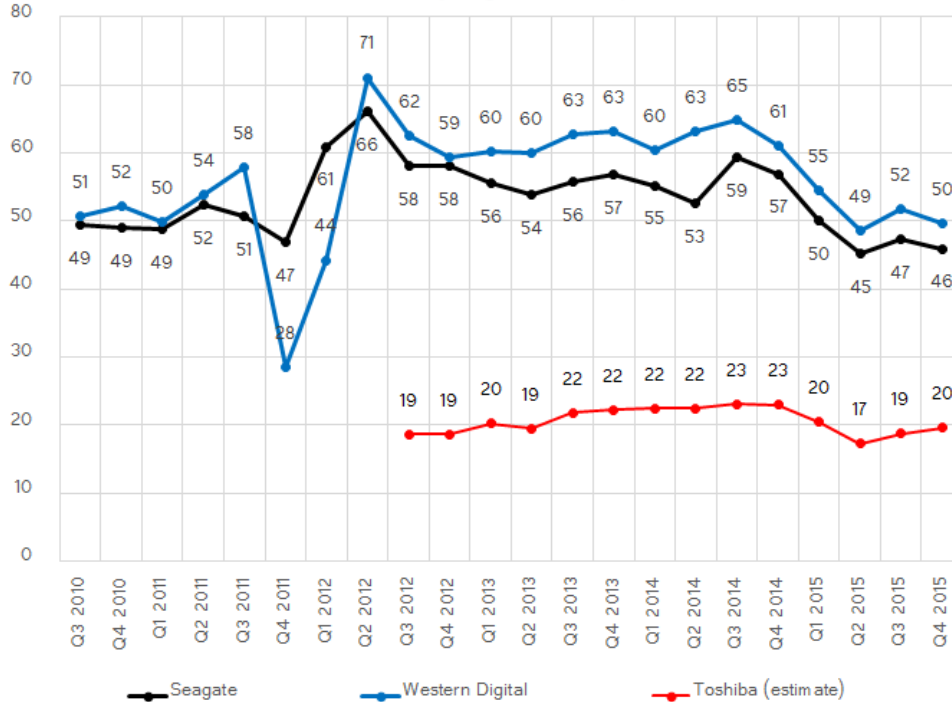


Source: Anton Shilov on March 2, 2016 <https://www.anandtech.com/show/10098/market-views-2015-hard-drive-shipments>

WD vs. Seagate

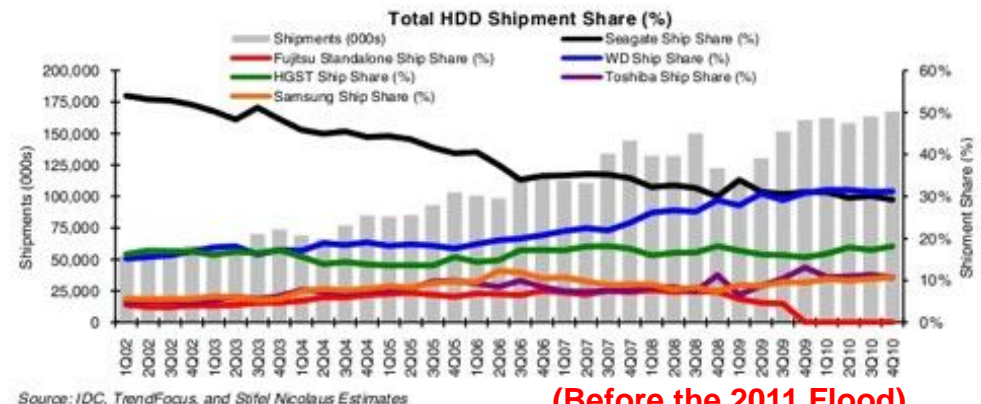
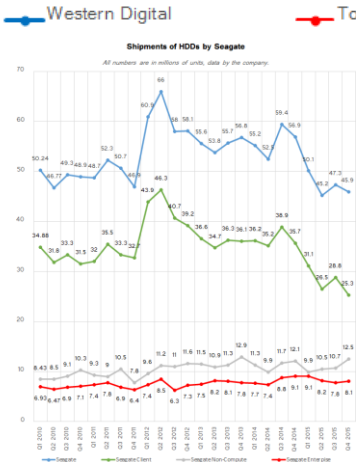
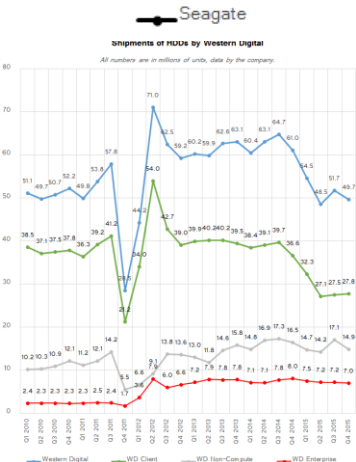
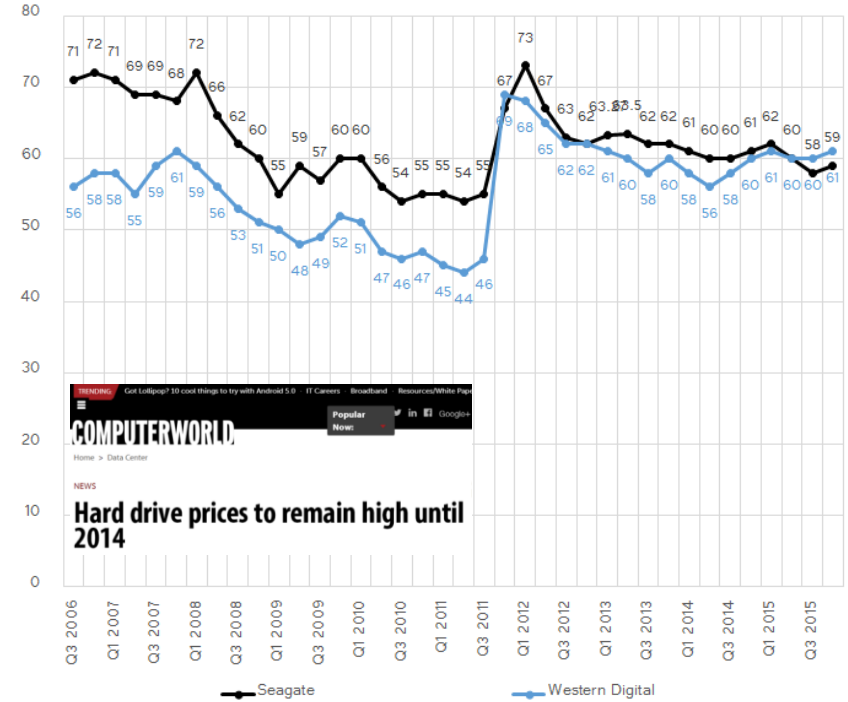
Shipments of HDDs by Seagate, Western Digital and Toshiba

All numbers are in millions of units, data by Seagate and WD. Shipments of Toshiba are estimates.



Average Selling Prices of Hard Disk Drives in \$USD

Data from Seagate's and Western Digital's filings with SEC.



重要啟示

- 泰國水災對HDD及SD的價格影響長達數年。
- Seagate在泰國水災後在市場價格較高時連續三季重回市占率第一名，並且在後續數年中持續因較高的價格獲利。(2011Q4,Seagate因水災輸出量下滑8%，WD則下滑51%)
- WD在泰國水災中不僅損失市場的市佔率，還讓對手Seagate在供貨不足引致的價格上升中獲得巨額的利潤 – *The worst business*。(2012前期WD收益降低35%，而Seagate收益則從USD150M暴增到USD563M)
- IC產業的價格敏感度極高且波動幅度大，加上產品週期短(Time Sensitive)，任何生產事故容易導致鉅額的財務損失。
- 風險管理不僅可以降低災害導致的損失，亦可進一步於競爭對手受災害影響時取得更有利的優勢。
- 2011年的泰國水災突顯風險管理、緊急應變管理及營運持續管理在電子產業的重要性，及電子產業供應鏈的災害特性。

- 複雜的供應鏈已使企業的風險全球化且跨產業。災害對於企業的影響不僅跨越國界也可能跨專業。
- 企業的風險管理應於企業設立與設廠時即須啟動，財務風險分析僅為其中一環。
- 企業的風險管理需整合風險管理、緊急應變、危機管理及營運持續管理的功能進行「全風險管理」(All-Risk Management)。
- 企業「全風險管理」最終目的是企業的永續經營。
- 緊急應變是企業風險管理的第二道防線，營運持續管理則是最後一道防線。
- 風險管理不僅能降低災害的損失，更能在競爭對手犯錯時取得主動的商業優勢。
- **千金難買早知道 –**
不要問風險管理需要花多少錢，先問如果沒有風險管理會損失多少錢！

人為災害與風險複合

ANTHROPOGENIC HAZARDS AND RISK CONVOLUTION

2014年高雄氣爆事件

2014 KAOHSIUNG PROPYLENE EXPLOSION

- 時間:
2014/07/31 23:56 to 2014/08/01 02:00
- 傷亡: 302人受傷, 32人死亡
- 損失: 約幾十億台幣
- 影響區域: 約 6km²
- 可能原因: 丙烯(Propylene)管線洩漏

- 缺乏風險管理的標準作業程序及不良的安全管理文化
Poor risk management SOPs and safety culture of MHF (Major Hazard Facility)
- 市政府缺乏風險管理
No risk management program with city government
- 市政府不良的風險管理文化
Risk culture of city administration
 - 缺乏風險意識
Risk awareness – illusive safety
 - Lower potential of natural hazards
 - Negligence of anthropogenic hazards (possibly due to high poll rating)
 - Group thinking
 - 缺乏風險通報機制
Poor mandatory risk reporting, let alone voluntary risk reporting
 - 風險決策不當
Poor risk-based decision making
 - 治理問題 – 部門間溝通不良
Governance – poor risk communication among departments

- 市政府緊急應變作業不良
Deficient city government contingency programs
- 缺乏溝通、指揮及專業能力
Poor communication (internal/external), command, and technological capacity
- 氣體洩漏事件的應變作業問題
Contingency plans for gas leak events:
 - Known and unknown sources
 - Confined and unconfined areas
- 爆炸事件的應變作業問題
Contingency plans for explosion events:
 - Toxic or non-toxic material
 - Known or unknown material
 - Evacuation and accommodation
- 淹水事件的應變作業問題
Contingency plans for flooding
- 疫情控制的應變作業問題
Contingency plans for disease control
- 夜間意外事件的應變作業
Contingency scenario for accident at nighttime

- 市政府缺乏事件危機處理能力
Incapacitated crisis management team of city government
- 市政府危機管理不當
Inadequate mechanism of crisis management
- 市政府各部門訊息管理不當
Poor information management of government agencies (event updates, requirement and allocation of resources, safety advise, etc...)
(g0v零時政府Hackfoldr平台)
- 災害認知的問題
Disaster
 - Explosion
 - Risk convolution: explosion/rain/disease
- 政府的問題
Government
 - Poor communication among departments
 - Political resolutions instead of technical resolutions

- 兩個獨立災害因子
Two Independent hazards:
 - Gas explosion
 - Torrential rain
- 不利的發生順序
Come in unfavorable sequence:
 - Rain after explosion
- 發生在不利的時間
Happen in unfavorable time
 - Summer
- 接踵而來的次生災害
Followed by secondary (consequential) events
 - Diseases
- 進一步與人為災害複合
Convolute further with human errors
 - Poor communication among departments in city government
- 導致更多的災害損失
Lead to crisis and more damage
 - Political criticism
 - Property damage and business interruption

結論
CONCLUSION

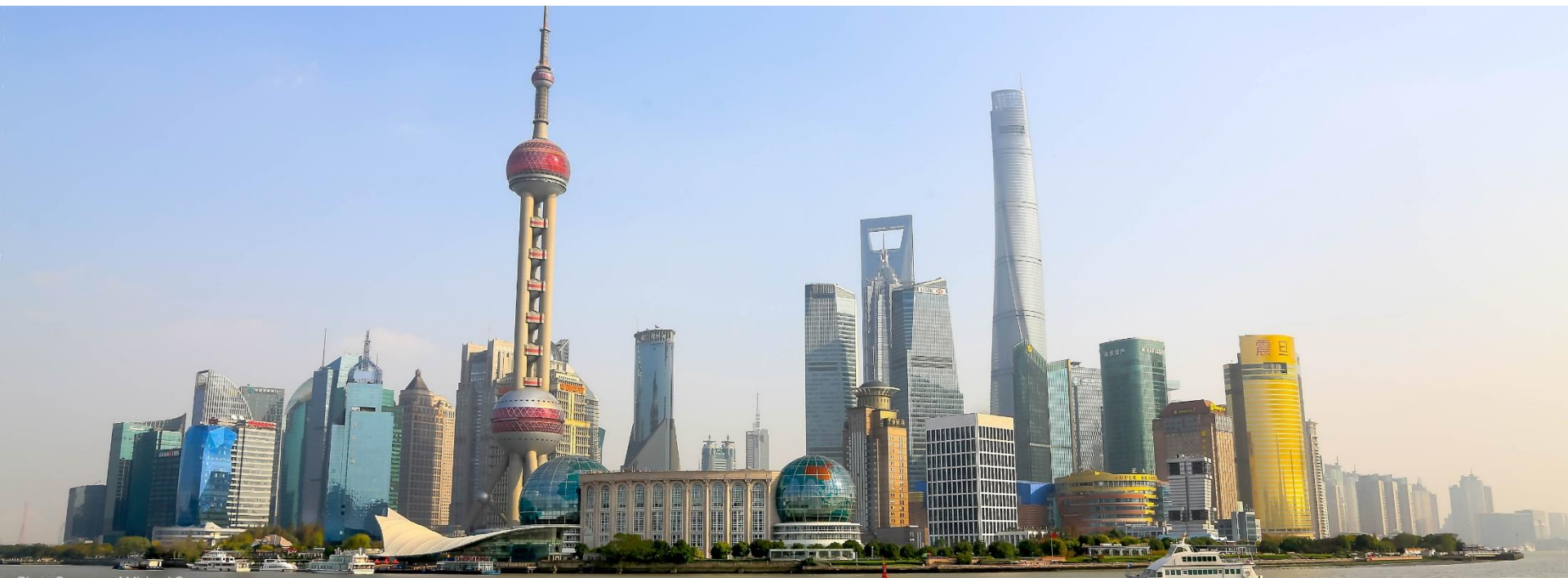


Photo Courtesy of Michael Cua



- 現代的商業模式產生新的災害情境，企業需有新的防災思維。
- 企業災害損失的根原可能跨越國界、產業及專業。
- 氣候變遷增加自然災害發生的頻率與後果，成為企業永續經營必須面對的課題。
- 企業需瞭解災害複合與次生災害的嚴重性並積極面對因應。
- 沒有「零風險」，只有災害發生機率的高低及適當管理的風險。
- 企業面臨的災害風險已非單純的財務風險管理可以處理，應考慮專業風險管理團隊的協助。
- 沒有一體適用的風險管理，只有客製化的風險管理方能真正協助企業有效管理風險。
- 企業應以「全風險管理」的做法維持長期的獲利及永續經營。
- 風險管理都有價格，但不是每個風險管理都有其價值。
- 最有效的風險管理就是以最少的資源管理最多的風險。

Photo Courtesy of Michael Cua

THANK YOU

Q & A

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