Withering and Flourshing: Destruction and Regeneration of the Land

枯與榮 大地的考驗與重生

郭寶章　從萬物角度看天災

Pao-chang Kuo Looks at Natural Disaster from the Perspective of Nature

寶島台灣，物產豐富，但相對的，天然災害也多。特殊的地理位置與地形構造，讓台灣常常面臨地震與颱風豪雨的考驗，再加上山地所佔比例高達三分之二、河川湍急、地質脆弱等因素，更容易引發山崩、洪水與土石流。這是我們無法迴避的環境限制。此次重創南台灣的莫拉克颱風，不過是大大戳破了人定勝天的迷夢。

狂風暴雨來襲，帶給人類巨大的生命與財產損失，除了感嘆天地無情，可有更深層的道理隱含其中？答案是肯定的，但首先，人類必須要退回到萬物成員的行列之中，從整個自然界的角度，才能一窺全貌。以下，台大森林系名譽教授郭寶章博士，以森林為例，協助我們跳脫本位、從宏觀視野來看待颱風與有關災害，同時，回頭檢視人類。

Rich in all sorts of domestic products, Taiwan has never been short of natural disasters, too. Due to its location and landform, Taiwan has constantly been challenged by quakes, typhoons and heavy rains. Mountainous terrains, torrential rivers and fragile geology have contributed to the occurrences of landslides, floods and mudslides. The severe damage caused by Typhoon Morakot proved once again this is something Taiwanese cannot turn away from.

Except the tragic loss in lives and properties inflicted by nature's blows, is there a deeper meaning hidden in all this? The answer is positive but requires humans to think as a member of all life forms and from a perspective of the Nature. In this article, Dr. Pao-chang Kuo, NTU Professor Emeritus of forestry, taking forests as an example, helped readers rethink the nature of typhoons and other disasters as well as human behaviors towards the Nature from a macro view.

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枯與榮，正是大地生生不息的循環方式。圖為雪霸國家公園通往桃山瀑布之步道美景。/ 陳志平攝
Withering and flourishing represents the Earth's circle of life.photo was taken by SPNP pass through the footpath of Tao Shan waterfall./Zhi-ping Chen

燎原野火後的灰燼，是森林的最佳養分 / 部落客 Valeriy 攝
Ashes derived from wild fires provide the best source of nutrients for the forests. / by Valeriy

能有綠意盎然的森林，還必須感謝颱風、火災及泥流的洗禮 / 余榮欽攝
Forests full of green is the gift from typhoons, fires and mudslides. / by Rong-chin Yu

永恆的自然法則

從森林出發，是因為它是陸地上最龐大、最複雜的生態系。自然界的法則，在這裡看得一清二楚。所謂自然法則，就是物競天擇、能量移轉、養份循環。為了能夠生存，必須要適應環境的變異，通過篩選而演替的物種，比較強壯，利於後代繁衍。另一方面，老化與死亡是所有生物的必經過程，地球的資源有限，唯有上一代生物的淘汰與退化，新的生命才能在有限的棲地上，繼續生長發展。

就像是水，以雨、霧、雪水或地表水、地中水、地下水等不同形態出現一樣，它是一種水文現象，在自然界生生不息的循環。水如此，生命亦然。

這正是自然界最奧妙之處。在新陳代謝、汰舊換新的基礎上，生命的火種得以一代代傳遞下去。個體短暫生命消失的背後，是整個族群的永續繁衍。新活力的不斷注入，讓地球資源永續。

促進自然界代謝的力量

進一步說明颱風之影響，颱風也會把病、老的枯朽樹木吹倒吹斷。郭教授估計，當一棵無能力繼續生存的大樹倒下，可以留出空地約30~50平方公尺的面積。這塊新生淨空的土地，不但讓幼苗、小樹有了成長環境，也因為陽光照射，而利於草地的形成。有了

Eternal Laws of Nature

Why forests? Because it is the largest and the most complex ecosystem on land, and shows the clearest picture of laws of Nature – natural selection, energy transfer, and nutrient cycling. In order to survive, life must adapt to environmental changes and evolve into a stronger species for its reproduction through natural selection. Aging and death are inevitable to all life forms. Only by elimination and degeneration of older generations will newer ones be able to grow on this habitat of the Earth, whose resources are limited.

Just like water that manifests in various forms, such as rain, fog, snow, surface water, groundwater, etc., and shows an ever-going cycling, life functions in the same way, too.

This is the marvelous mechanism of Nature. Life passes on its seeds on the basis of replacing the old with the new. Behind the temporary disappearance of individual lives is the everlasting existence of the entire species. New energy keeps flowing into the Earth to make its resources sustainable.

Spurs for Metabolism of Nature

Offering a more detailed illustration on the effects of typhoons, Kuo estimated that every old and dying tree felled by a typhoon would clear out an area of 30 to 50 square meters that allows seedlings and young trees to grow. Also, the sunlight will be able to fall upon the ground to facilitate

草地，就會吸引草食性動物，以及以草食性動物為食的肉食性動物取食與發育，因為食物鏈的關係，一個新的生態系就產生了。

因此，大風吹過，不只帶走了平日無法遠播的種子、擴展植物生命力，也帶來了新的動、植物。倒塌的樹木，雖然自身的生命終結了，卻提供了地表其他生物重要的取食與生存空間。若枯木倒臥在小溪旁，則會促成礫石堆積和大小水池，是魚類與昆蟲的棲息地。枯倒的樹木與落葉殘體會分化為有機質，回歸土壤，提供幼苗與樹木生長所需的營養。生命便如此延續循環下去。年輕幼壯的樹木有旺盛的條件進行光合作用，這是老朽的樹木所不及的，因此新的生命加入，對地球生態減碳機能的維持，非常重要。

當然，森林面臨的威脅不只是風災，還有火災。同樣的，火災也是促進森林再生的動力。火燒過後，過厚的地表物被燒盡，讓種子容易接觸到土壤，增加著床機會。新的生命蓄勢待發，展開另一輪的森林演替。從整個森林的範圍縮到樹木本身，風災、火災的意義也是相同的。

而一個歷經災難洗禮後的森林，有著較健康的生長與發育，往往對疾病、害蟲和氣候變化有更好的抵抗力。自然災害在改變環境的同時，也帶來了重建與新生的契機。沒有這番擾動與刺激，今天的生態系，樣貌不會這般多元豐富，這又是生物多樣性的一個觀念。

the forming of grassland, which attracts herbivores and in turn carnivores. Due to the mechanism of the food chain, a new ecosystem will be generated.

Strong wind of typhoons not just takes seeds to places afar to broaden life possibilities of plants, but also brings new plants and animals. Fallen trees, despite the termination of their own lives, provide essential space for other life forms to feed and live. Trees that fall beside a creek would create ponds and puddles as great habitats for fish and insects. Fallen trees and leaves would also become organic matter in the soil, providing nutrients for younger trees, whose potent photosynthesis is crucial to carbon reduction for the Earth's ecology.

In addition to typhoons, forests also face the challenge of fire, another stimulus that boosts the regeneration of forests. As the fire burns up a thick layer of ground surface, it's easier for plants' seeds to get to and settle in the soil, and these new lives are ready to form a new generation of the forest. This is true to any species of tree itself, too.

The test of disasters brings forests a better and healthier growth and development and a stronger ability to resist diseases, pests and climate change. Natural disasters create opportunities of reconstruction and regeneration while changing the environment. Without these disturbance and stimulation, today's ecosystem wouldn't demonstrate such biodiversity.

狂風把枯葉吹落，讓陽光得以穿過茂密的森林照射到地表，落葉則成為肥料。有了空間與陽光，很多植物與動物、微生物等都能夠繁榮生長了。圖為台灣黃蝶 / 陳志平攝

Forests full of green is the gift from typhoons, fires and mudslides. The picture above is *Eurema blanda arsakia (Fruhstorfer)* . / by Zhi-ping Chen

減少人為侵擾，維繫完善的水土保持，才是國土永續的基礎 / 陳志平攝
Minimizing human interference and maintaining good water and soil conservation are keys to the sustainable development of our national land. / by Zhi-ping Chen

森林的防災與調節功能

雖然自然災害有其生態上的正面意義，但躲避災難，仍是所有生物的本能。事實上，森林對大部分的生物乃至於人類，都是極佳的庇護所，在防風、防火、防海潮、防洪患，以及保持水土和調節氣候上，森林都能扮演關鍵性的角色。以水土保持來說，交錯的樹根在地表地下形成綿密的保護網，並伸至深層土壤岩石，如同打樁般，捍衛著地盤的穩定，減緩了土石流的發生。此外，林地表土具有諸多孔隙，利於水之滲透、滲漏，發揮了水質淨化與水量儲存、減低地表逕流的功能。「森林的地下以達岩層就是一座大的天然貯水庫，能減緩地表水之沖擊，增加地下水的持續利用。」郭教授緩緩的說。

放眼今日世界，節能減碳是最受關注的環保議題。綠色植物在行光合作用時會消耗空氣中二氧化碳，因此，在減低二氧化碳降低溫室效應的貢獻上，森林功不可沒。雖然森林的生態地位如此重要，卻因為人類生活所需、經濟發展與土地利用，導致森林面積逐漸縮小，熱帶雨林即為一例。最後，伐林爭地的惡果由所有生物共同承擔。郭教授

How Forests Help Fight Against Disasters

Although natural disasters have positive effects on ecosystem, all creatures are instinctively inclined to shun them. Forests provide the best shelter to most creatures including humans, and play a pivotal role in fighting against wind, fire, tides, floods, in conserving water and soil, and in moderating climate. For example, the intertwining roots of trees would extend deep into the rock stratum, hold firm the ground and protect the soil, which prevents many possible mudslides. Besides, the porous topsoil may facilitate the permeation, purification and storage of water. “Under forests, from topsoil to rock stratum, hides a natural reservoir that eases the washing torrents of surface water and prolong the use of groundwater,” said Kuo.

Today, energy saving and carbon reduction are the hottest issues in environmental protection. As photosynthesis of green plants consumes carbon dioxide, forests make considerable contributions to countering greenhouse effect. Despite its importance in ecology, forests, such as rainforests, have been

憂心的直言，「全球環境的沙漠化、溫暖化與氣候變遷，都與森林的日漸消失有關！」

加強森林與環境保育

沒錯，天然災害的發生，是大自然運行的法則。但當災難發生的頻率與強度，都大幅超過長久以來的平均值時，將是所有生物與土地無法承受之重大災禍。各種證據顯示，人類之超限利用、大量的破壞環境、濫用自然資源與石化能源，間接造成了氣候異常，以致天災頻傳。全球森林遭受濫墾的面積，每年皆以驚人的數量增加。對森林生態系來說，「人禍」似乎是致命的根源。而當森林的防護、調節功能被削弱時，也意味著，人類有更多的天然災害要面對。

現在，全球森林的面積僅剩陸地的30％左右，郭教授認為，這項僅有的自然資源，必須加以審慎的保育，對整個地球的生態穩定才是安全。回到台灣，森林面積佔50%，人們應該慶幸，政府與民間也該捫心自問，我們真的有珍惜這片山林嗎？還是仍要繼續的伐木、開路、修橋，把每個地方都大力發展成遊憩區？郭教授以日本為例，森林面積佔陸地68%，無論是官方或社會大眾都重視森林保育，遊覽日本各地皆可看到綠地美景，如此全民對森林價值的重視與愛護，值得吾人借鏡。

郭教授嚴肅的提醒我們，自然的力量太巨大了，人定勝天的觀念必須改正。所有的土地利用，都要把環境限制的因素考慮進去，否則必然遭到生態的反撲，招致更大的自然傷害。不可預測的災害，特別是聖嬰現象發生頻繁，讓人類居住安全相形渺小，但也讓我們學會尊重自然法則、瞭解環境保護的重要。畢竟，謙卑地與大自然共生，才能長長久久。

diminishing because of humans' selfish needs. At the end all life forms must suffer from the tragic results of excessive logging and land exploitation. “Global desertification, global warming and climate change all have to do with the gradual disappearance of forests,” said Kuo.

Conservation and Education Much Needed

Indeed, natural disasters are part of the laws of Nature. But when their frequency and severity far exceed the long-term averages, the damage will be too much for all creatures and land. Exploitation, destruction, overuse of natural resources and energy by humans are proved to have indirectly resulted in climate abnormalities and frequent disasters. The areas of exploited forests are increasing in staggering numbers. In fact, as humans are the cause of weaker functions of forests, they also become the victim of more and severer natural disasters.

Today, forests take up only 30% of the land on Earth. Kuo believed people must protect and conserve this special natural resource to ensure a stable ecology and a safe environment. In Taiwan, forests cover 50% of the land. All Taiwanese and the government should feel fortunate but at the same time ask: have all these forests been well cherished? Or will there still be more and more roads, bridges and tourist attractions to come at the expense of the forests? Kuo recommended Japan, which highly values forests, as a model for Taiwan to learn how to conserve and protect forests.

Kuo solemnly reminded readers that Nature is so powerful that humans must discard the idea that man can conquer it no matter what. Any form of land use must consider all the environmental constraints lest Nature would deal heavier blows. Unpredictable disasters, especially those caused by El Nino, not only make human lives become insignificant, but also force humans to realize the importance of environmental protection. It requires mankind to coexist with Nature in a humble manner to ensure long-lasting survival.

郭寶章博士簡介
Profile of Dr. Pao-chang Kuo

郭寶章，1925年出生。美國密西根州立大學森林資源系碩士、日本九州大學農學博士，曾於林務局工作一年，1948年起，在國立台灣大學任助教以達教授，長達48年。現為台灣大學森林環境暨資源學系榮譽教授，作育無數英才。

Born in 1925, Kuo obtained a M.S degree in forestry at Univ. of Michigan (U.S.A) and a Ph.D. in agriculture at Kyushu University (Japan), and had worked for Taiwan's Forestry Bureau for a year. He had worked as T.A, Lecturer, Asst. Prof., and Prof at National Taiwan Univ. since 1948 for over 48 years, and is currently an emeritus professor of School of Forestry and Resource Conservation at NTU.