出國報告（出國類別：國際會議）

出席「第四屆國際水協會亞太地區會議與展覽會」報告

服務機關：台灣自來水股份有限公司
姓名職稱：陳福田總經理
蕭宏民專門委員
李丁來副處長
蕭再興主任
周國鼎組長
派赴國家：日本
出國期間：100 年 10 月 2 日至 6 日
報告日期：101 年 1 月 4 日

摘要

「第四屆國際水協會亞太地區會議與展覽會」(The 4th IWA-ASPIRE Conference & Exhibition)由身兼中華民國自來水協會理事長之台灣自來水公司總經理陳福田率產、官、學各界人士共 73 人出席；期程為 2011 年 10 月 2 日至 6 日。

出席該會展之目的除部分團員發表論文、參加「第四屆亞洲自來水事業人力資源發展網絡會議」會議外，並順道參觀當地自來水科技及設施，以汲取先進國家之自來水處理發展與應用經驗，同時進一步瞭解自來水事業的未來發展趨勢，以供我國自來水經營、管理之相關機關參考。

我國參展攤位主題是「台灣的好水、好材、好表」，由中華民國自來水協會、台水公司、台北自來水事業處（以下簡稱北水處）、台灣大學、交通大學、興南公司及弓銓公司等產官學單位共同展出。

本次會議達成以下重要決議：

一、由台水公司承辦 2012 年「第五屆亞洲自來水事業人力資源發展網絡會議」。

二、由我國承辦 2014 年第五屆 Asia-Pacific Young Water Professionals (YWP) 研討會。

三、由中國大陸中科院代表承辦 2015 年第六屆 IWA-ASPIRE 會議。

目次

出席「第四屆國際水協會亞太地區會議與展覽會」報告

一、目的

本次出席「第四屆國際水協會亞太地區會議與展覽會」(The 4th IWA-ASPIRE Conference & Exhibition)（簡介見附錄 1）（識別標誌見圖 1）之目的除部分團員發表論文、參加「第四屆亞洲自來水事業人力資源發展網絡會議」會議外，並順道參觀當地自來水科技及設施，希望收集包括廢水處理、水質監測、都市供水、海水淡化及節水技術等相關資料，以汲取先進國家之自來水處理發展與應用經驗，同時進一步瞭解自來水事業的未來發展趨勢，以供我國自來水經營、管理之相關機關參考。

圖 1 大會識別標誌

二、團員及行程

本次出席「第四屆國際水協會亞太地區會議與展覽會」之我國代表團由身兼中華民國自來水協會理事長之台灣自來水公司（以下簡稱台水公司）總經理陳福田率產、官、學各界人士共 73 人（部分團員合影見圖 2）所組成，其中台水公司出席發表論文之團員包括蕭宏民專門委員、李丁來副處長、蕭再興主任及周國鼎組長；期程為 2011 年 10 月 2 日至 6 日（行程表詳見附錄 2）。

圖 2 部分團員合影

三、會場簡介

「第四屆國際水協會亞太地區會議與展覽會」於 2011 年 10 月 2 日至 6 日在造型獨特之東京國際論壇（Tokyo International Forum）（見圖 3 及圖 4）舉行。東京國際論壇（配置圖見附錄 3）爲東京都內之地標建築物，交通便利，公車及捷運均可到達。

圖 3 東京國際論壇外觀

圖 4 東京國際論壇內部

四、會展概述

「第四屆國際水協會亞太地區會議與展覽會」之主要活動包括研討會、展覽及技術參觀等三部分。

研討會歷時三日，共有 900 多篇論文發表，分別包括 650 篇口頭發表論文及 350 篇海報論文，另有 9 個 Workshop 及一系列的 Industry Forum，論文發表與研討會分別於 15 個會場同時舉行。

身兼中華民國自來水協會理事之台大環工所駱尚廉教授在 2011 年 10 月 3 日下午被邀請至由韓國首爾國立大學教授 Mooyoung Han 及日本東京大學

Hiroaki Furumai 教授共同主持主題爲「Asian Wisdom of Water Management to Adapt Climate Change」之 Workshop 參與討論。其中屬於乾旱國家的伊朗代表 Mohsen Taghavi 先生所提到他們祖先使用的 Qanat 系統，令人讚嘆先人的智慧。Han 教授希望駱尚廉教授也能於次年於韓國釜山召開之大會時，提出一些台灣先人的供水智慧與技術事蹟，供大家分享。

展覽如同研討會亦爲期三日，場地則位於日本東京國際論壇之 B2 廳，共有 44 個攤位參展（見圖 5），其中社會團體之參展單位包括國際水協會(International Water Association, IWA)、中華民國自來水協會(Chinese Taiwan Water Works Association, CTWWA)、日本水道協會(Japan Water Works Association, JWWA)及日本水道局等。

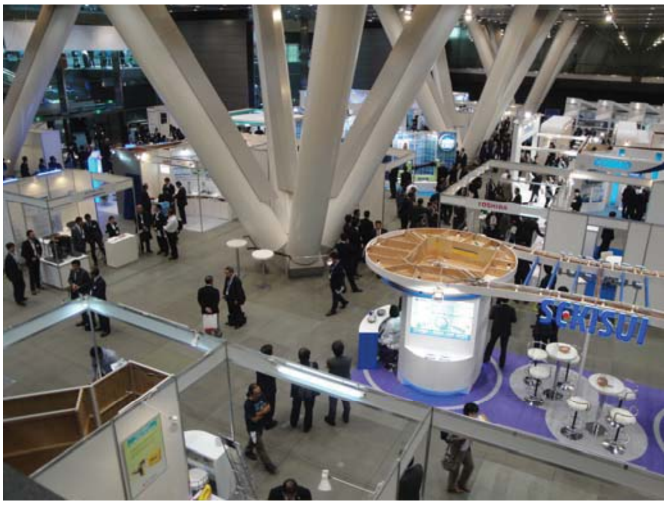


圖 5 展館現場

我國參展攤位主題是「台灣的好水、好材、好表」，由中華民國自來水協會、台水公司、台北自來水事業處（以下簡稱北水處）、台灣大學、交通大學、興南公司及弓銓公司等產官學單位共同展出。

台水公司及北水處除於現場介紹其供水業務，台水公司也提供自行生產的瓶裝水供參觀者取用。台大環工所展出對於水資源教育之重大貢獻，交通大學則介紹「Q Water 村落型緊急供水套裝模組」，該模組主要用於高濁度水源時之淨水，組裝相當方便。我國產業界之代表興南公司於現場介紹其石墨鑄鐵管之製造流程；弓銓公司則展示全球第一只非磁傳動的電子水表，該水表可以其水滴警示漏水現象，並配合壓力計的無線傳訊記錄器進行水量、水壓之監控管理。

國際水協會會長 Glen T. Daigger 博士、世界衛生組織(WHO)之尼泊爾代表、泰國水利單位(MWA)、日本 NHK 及各商社等貴賓對於我國之展覽攤位極爲喜好。

除了產官學界之展出內容，我國展覽攤位並以大型電視播放 1920 年由日本技師八田與一負責設計、監造烏山頭水庫之 47 分鐘歷史影片。值得一提的是日本水道協會人員參觀我國之展示攤位後，均對參觀烏山頭水庫表達高度興趣；新瀉市水道局長元井悅朗先生亦表示希望有機會參觀台灣嘉南大圳、設計者八田與一之紀念館。

本屆展覽會比較特別之攤位是 Water Bar（見圖 6），該攤位將數十個各國水道局生產的自來水、瓶裝展示，由服務人員依參觀者意願指定要哪一家水道局之生產水，服務人員就爲你服務。

圖 6 Water Bar

五、會展歡迎酒會及揭幕

(一) 歡迎酒會

「第四屆國際水協會亞太地區會議與展覽會」之歡迎酒會（見圖 7）在 2011 年 10 月 2 日下午 6 時舉行，現場除備有簡單餐飲外，並有人影剪紙藝術表演，吸引眾多來自世界各地的與會人士。

圖 7 歡迎酒會現場

(二) 揭幕式

「第四屆國際水協會 ASPIRE 研討會及展覽」(The 4th IWA-ASPIRE Conference & Exhibition)的揭幕式於 2011 年 10 月 3 日上午 9 時 30 分在東京國際論壇的 C 大廳舉行，現場與會人員約 800 人（見圖 8）。

圖 8 揭幕式

揭幕式由會議主席 Shinichiro Ohgaki 教授主持，多位貴賓親臨致詞，依序包括國際水協會秘書長 Paul Reiter 先生、東京都知事 Shintaro Ishihara 先生、日本厚生省處長 Hiroyuki Ishitobi 先生、國土交通省處長 Masanobu Miyazaki 先生、環境廳處長 Nobuo Yoshida 先生以及國際水協會前主席 Norihito Tambo 教授。

貴賓之一的東京都知事 Shintaro Ishihara 先生（見圖 9）在致詞時指出，東京都的自來水都需經過多道淨水程序，因此該自來水具有世界第一的品質；雖然日本今年遭受到大地震的影響，部分地區甚至受到輻射的污染，

不過東京的自來水不僅潔淨無雜質，而且完全沒有受到輻射的污染，他並鼓勵所有遠道而來的外國與會者於停留東京期間直接生飲享用自來水。此外，Ishihara 知事還特別提及，由於對自家高品質的自來水深具信心，東京都爲日本第一個生產銷售瓶裝水的市政當局，現在日本許多其他都市也開始起而效尤。

圖 9 東京都知事 Shintaro Ishihara 致詞

爲人風趣的 Norihito Tambo 教授（見圖 10）爲國際水協會的首任主席，致詞時他除了講述國際水協會的歷史以及 Aspire 的由來，也深知日本人一向不善使用英文，因此特別呼籲所有日本籍的與會者在發表論文時務必「Speak Slowly and Clearly」，以免沒有人聽得懂。

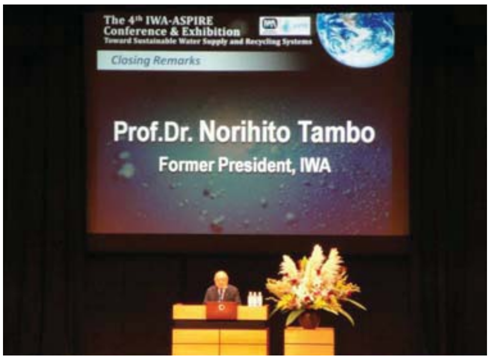


圖 10 Norihito Tambo 教授致詞

六、專題演講

在揭幕式後，分別由日本 Tokiwamatsu Gakuen 教育基金會董事長 Yasumoto Magara 博士主講「Innovation of Water Supply System in a Population-obligation and a Low Carbon Society」、韓國 IWA 國家委員會主席 Zuwhan Yun 教授主講「Water Mega-Projects and Future of Water Works」，以及

IWA 會長 Glen T. Daigger 博士主講「Accelerating Change in the Water Profession to Close the Gap Between Needs and Performance」。

三場專題演講之後，出席人員便移至展覽會場，由 Ohgaki 教授、Tambo 教授、Daigger 會長及 Paul Reiter 執行長等人剪彩開幕，正式展開研討與展覽會活動。

七、感謝中華民國自來水協會義舉

日本受到 311 震災重創後，我國中華民國自來水協會理事們發揮「人溺已溺」之精神主動捐助賑災，日本水道協會專務理事為此義舉特別在此次會展中頒發感謝狀，向該協會致意，並由中華民國自來水協會陳福田理事長代表接受（見圖 11）。

圖 11 陳福田理事長代表接受感謝狀

八、大會晚宴

大會晚宴於 2011 年 10 月 5 日晚上 7 點至 9 點盛大舉行，除東京都副知事及前首相森喜朗先生等人出席致辭，現場並有別開生面的開啓酒桶儀式（見圖 12）、及管弦樂、魔術與日本傳統歌舞表演等，與會的各國來賓也趁此機會交流及拍照留念（見圖 13）。

圖 12 開啓酒桶儀式

圖 13 與前首相森喜朗先生合影

九、台水公司同仁論文發表

台水公司同仁於本次會議共發表三篇口頭論文及三篇壁報論文，論文題目如下表所示：

論文題目	發表人	發表方式	備註
Promote the Reliability of Water Distribution Systems with in Time Management Model of Monitoring Systems	蕭宏民專門委員	口頭	見附錄 4
Adaptation Strategies to Climate Change for water supply: The experience of Taiwan Water Corporation	李丁來副處長	口頭	見附錄 5
Challenges of Taiwan's Water Supply	周國鼎組長	口頭	見附錄 6
The Emergency Treatment Study of Excessive DOC from Bottom Layer Reservoirs Water	李丁來副處長	壁報	見附錄 7
Applicability Study of Full-Scale Filter Filtration and Backwash Performance Assessment Methods	李丁來副處長	壁報	見附錄 8
Case Study of Booster Chlorination in Water Distribution Network in Kaohsiung City	蕭再興主任	壁報	見附錄 9

十、第四屆亞洲自來水事業人力資源發展網絡會議

「亞洲自來水事業人力資源發展網絡會議」(The Asian Waterworks Utilities Network of Human Resources Development)係由東京都水道局於 2007 年所發起，第一屆於 2008 年由該局主辦，主要目的在藉由分享自來水事業人力資源發展知識及經驗，以提升亞洲地區自來水事業之經營績效；2009 年由

韓國首爾市政府自來水局主辦第二屆；2010 年由台北自來水事業處主辦第三屆；東京都水道局復於 2011 年與國際水協會亞太區年會(IWA-ASPIRE)合作主辦第四屆。

本屆會議除日本東京水道局外，共有韓國 K-water（2 人）、泰國 Metropolitan Waterworks Authority（10 人）、北水處（3 人）及台水公司（2 人，由供水處李丁來副處長及第七區管理處檢驗室蕭再興主任代表參加）（會議剪影見圖 14、15），並由李副處長發表「Systematic Approach to Upgrade Water Treatment Plants in TWC」（見圖 16），與各國代表交流經驗。

圖 14 亞洲自來水事業人力資源發展網絡會議與會人員合影

圖 15 台水公司及北水處出席人員與東京都水道局局長 Mr. Shigeki IMAI 合影

由於東京水道局相當重視其對於國際協助及技術合作暨訓練等之績效，亦列入該局之 KPI 中，故積極推動建立亞洲自來水事業人力資源發展網絡，並扮演龍頭角色，推廣該局之管理、規劃及風險管理、技術傳承、淨水、供配水、漏水預防、水質、氣候變遷等專門知識及技術暨人才培訓及養成，尤其是降低漏水方面表現，更是該局引以為傲之成果。

圖 16 李丁來副處長發表簡報

由於各國希望由台水公司舉辦 2012 年「第五屆亞洲自來水事業人力資源發展網絡會議」，故 2012 年會議主題是「提升亞洲自來水事業之服務能力」(Capacity Enhancing in Asian Water Utilities)，研討重點以台水公司提出之「無收費水量管理」(Non-Revenue Water Management)爲主，並獲北水處、韓國 K-Water 及東京水道局同意。

十一、技術參觀

技術參觀於 2011 年 10 月 6 日舉行，過程說明如下：

(一) 金町(Kanamaehi)淨水場

金町淨水場位於東京都之東側，建立於 1926 年，爲東京最老之淨水場。經過 7 次之擴建，目前之出水量爲每日 150 萬立方公尺，供水人口 250 萬。原水取自附近之 Edo 河，其傳統之淨水程序爲沉砂池、快混池、上流式膠凝沉澱池及快砂濾池，處理水則貯於清水池，再經由抽水機打入配水系統。1992 年起爲提升水質，首先每日有 26 萬立方公尺之水經高級處理，係將膠凝沉澱池之出水，導入臭氧接觸池，然後再經粒狀活性碳濾床（形成所謂之生物活性碳床），活性碳濾床之出水再經快砂濾床。高級處理之目的在於加強去除臭味、三鹵甲烷前驅物及其他傳統淨水程序無法去除之物質。

經 1996 年之擴建，目前經高級處理程序之水量爲每日 52 萬立方公尺。且擴建工程仍正在進行中，預計幾年後，所有之出水皆經過高級處理。

該廠之生物活性碳濾床約每 72 至 96 小時，以空氣及水併同反沖洗，而粒狀活性碳約每間隔 4 年需進行再生。快砂濾床採單一濾料，濾砂之有效粒徑爲 0.6 mm，均勻係數 1.3，厚度爲 60 或 65 cm。其反洗頻率在傳統淨水部份爲每 72 小時，在高級處理部份則爲每一個月反洗一次。該廠所用之混凝劑爲多元氯化鋁(PACl)，液氯用於氧化鐵、錳、氨氮及消毒，在傳統處理程序可加於快混池或/及膠凝沉澱池，依原水水質而定。高級處理部份，氯則加於生物活性碳床之出水。在原水質較差時，傳統淨水程序之部份亦會在沉砂池進水處加入粉狀活性碳。

金町淨水廠爲確保在緊急狀況，如地震等天然災害發生，外來電力供應中斷時，有足夠之動力來源，於 2000 年就在廠內建立汽電共生系統，平日以瓦斯爲燃料，有災變時，可以貯存於地下桶槽之煤油爲燃料，同時利用所產生之廢熱來乾燥污泥。另外爲節能減碳，該廠於 2006 年起在快砂濾床上加裝太陽能發電裝置，一方面防止外來之污染，一方面加強綠色能源之使用。

(二) 東京都水科學館(Tokyo Water Science Museum)

東京都水科學館透過影音多媒體、實物展示、互動式遊戲及動手作實驗等方式，來增進社會大眾，特別是年青學子，對水資源及自來水之認識，進而珍惜它、愛護它。首先「水之旅(Aqua Trip)」係利用多媒體來介紹水文循環，其次「水森林(Aqua Forest)」，以多摩川(Tama River)上游 Okuama 地區之森林，以至於羽村取水堰(Hamura Intake Weir)之空照圖、瀑布、大樹及河川等之照片來說明森林與水源之相互關系，及保護森林對都市穩定且高品質原水供應之重要性。另一部份「水實驗室」(Water Laboratory)主要是介紹淨水程序，包括傳統之混凝、沉澱、過濾程序及高級處理之臭氧、生物活性碳及薄膜程序，並設計有各種遊戲及實驗來增進參觀者之興趣與認識。「水之城」(Aqua Town)則以模型介紹自來水如何供給到每一戶人家，以至每一樓層，及自來水與日常家庭生活、辦公室、學校以至於工廠間之關係。

(三) 東京都水道局之水質管理中心及供水操作中心

東京都水道局之水質管理中心(Water Quality Management Center, WQMC)及供水操作中心(Water Supply Operation Center, WSOC)兩者位在

同一棟大樓內之不同樓層，水質管理中心之主要工作包括：河川及水庫等水源水質之監測，共約有 60 個採樣點，每月採樣一次。淨水場之水質監控，針對水道局屬下之 11 個主要淨水廠，進行處理流程各單元之水質監測。WQMC 主要進行原水及清水內重金屬、揮發性有機物、農葯、致病性原蟲等之分析。透過全區 131 個自動水質計來監控配水管網內之水質，自動水質計分析之項目包括濁度、色度、餘氯、pH 值、導電度、水溫及水壓等 7 項。透過資訊網路系統，控制中心可及時掌控即時之水質狀況。

對於突發之緊急水質事件，WQMC 除可透過資訊網路，連絡相關單位處理外，亦可用緊急事故處理車及移動實驗室趕赴現場處理。用戶對水質抱怨之處理亦是中心任務之一。在研究發展方面，WQMC 進行水庫水質之改善，高級淨水程序，包括薄膜程序效能之提昇，及三氯胺生成之控制等。另外 WQMC 亦辦理自來水相關設施之參訪活動及親子水質教育活動等，以增進大眾對公共給水之瞭解。該中心之水質分析實驗室擁有相當多之精密儀器，包括 GC-MS、ICP-MS、LC-MS-MS、Pyrolysis-GC-MS、FT-IR、SEM-EDX 及 Phase Contrast Fluorescence Microscope 等。

供水控制中心(WSOC)之主要任務在於確保安全質優飲用水之穩定供應，其執行方面係透過集水區之水文資料，水庫水位及蓄水量，原水取量、淨水場出水量等資訊之收集，配合用戶端用水量趨勢之推估，及各配水池之水位，水量等資料，經由各供水站（包括配水池及加壓站）抽水機操作之調控，以使全區可達到適當水壓與水量之目的。水道局在整個供水區域總共裝置了 313 個水壓及流量偵測站（所謂 Telemeter），併同前面所述之 131 個自動水質計，再加上水源集水區之天氣，水文資料及原水取量等資料，均送到 WSOC 之電腦主機及控制室，並展示於控制室牆面上巨大之供水網路電腦圖示上，由該圖可得知各供水站主要幹管之水壓、流向及流量，控制中心可經由資訊，來調整加壓站抽水機之操作，以使能更精確地配合用水端需求之變化，並達到能源之有效應用。根據統計水道局全年之用電量達到 8 億度，其中 60%爲抽水機所用。再者當某一監控點之水壓、流量或餘氯濃度超過預先設定之上、下限值時，系統會自動發出警告，提醒操作人員注意。另外，控制室亦有備援系統，當地震等天然災害破壞主控制室時，可在備援之控制室繼續操作。

十二、心得及建議

(一) 日本「水道產業新聞」專刊除介紹本屆大會活動及展覽器材外，特別刊登三張照片是我國在 2009 年舉辦的第三屆 IWA-ASPIRE 會議；而且還分別在 ASPIRE 理事會及大會閉幕典禮上被提及該屆會議爲一成功的典範。而代表我國的國家代表台大駱尚廉教授在 2005 年於新加坡 ASPIRE 理事會中所作的簡報也成爲各國代表沿用的範本，可見我國以往努力與用心的成果被各國所肯定。

(二) 台水公司如有計畫積極參與該局各方面技術暨人才培訓及養成知識、經驗交流（過去幾年北水處在東京水道局之技術經驗協助下，於降低漏水方面展現明顯進步成效），當有助於提升台水公司各方面業務之處理能力。

(三) 「降低漏水率」是台水公司當前業務重點之一，如能藉「人力資源發展網絡」加強與東京都水道局及其他亞洲自來水事業之合作關係，引進相關管理及技術實務經驗，當有助於台水公司精進業務。

(四) 以往台水公司未曾舉辦類似國際自來水事業間研討會議，如藉由主辦「第五屆亞洲自來水事業人力資源發展網絡會議」，當可增進台水公司同仁參與國際交流之經驗，培育及強化多層面國際交流人才，逐步朝「成爲國際級自來水事業」之願景邁進。

(五) 中國大陸中科院代表於本屆大會中提出承辦 2015 年第六屆 IWA-ASPIRE 會議的計畫書並進行簡報，獲得理事們的一致通過。

(六) 駱尚廉教授代表我國提出承辦 2014 年之第五屆 Asia-Pacific Young Water Professionals (YWP)研討會的書面計畫書並作口頭說明，亦獲得全體理事的同意，取得該次會議的主辦權。

(七) Program Committee 主席 Keisuke Hanaki 教授（東京大學）宣布參加此次會議的人數超過 1,300 人。

(八) 駱尚廉教授等人共同發表之論文「The optimal operation of rapid filtration to avoid transient turbidity penetration」獲得最佳海報獎（共有 10 名）。

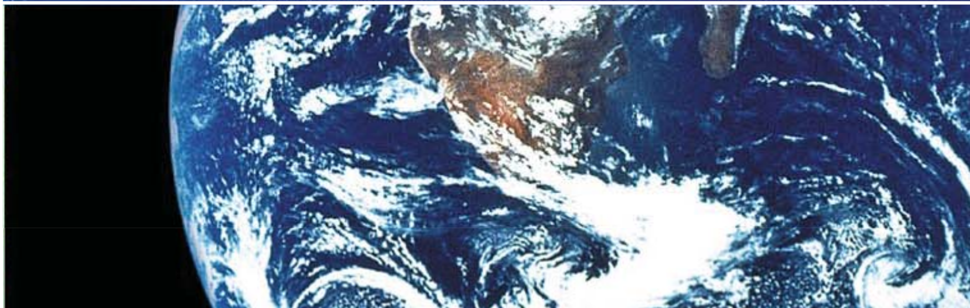
附録1

The 4th IWA-ASPIRE Conference & Exhibition

Toward Sustainable Water Supply and Recycling Systems

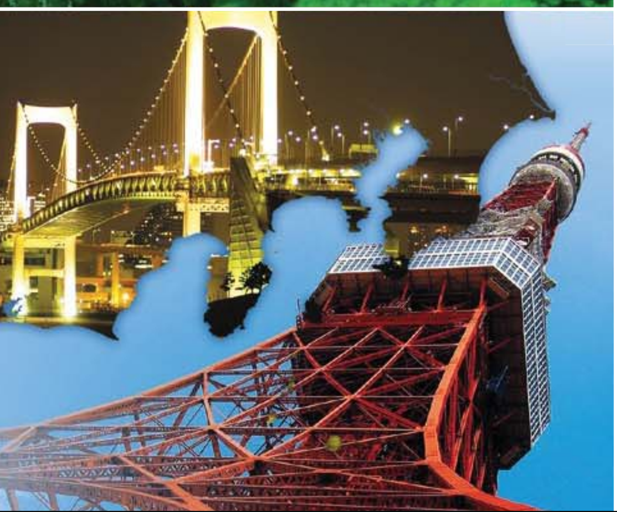
2nd Announcement

Call for Papers



2-6 October 2011

Tokyo International Forum, Tokyo, Japan



Organizer **The 4th IWA-ASPIRE Organizing Committee**

Co-Organizers Bureau of Waterworks, Tokyo Metropolitan Government
Bureau of Sewerage, Tokyo Metropolitan Government
Japan Society on Water Environment
Japan Water Works Association
Japan Sewage Works Association

The 4th IWA-ASPIRE Conference & Exhibition

Welcome Message

The 4th IWA-ASPIRE Conference & Exhibition will take place in Tokyo, the capital of Japan, for five days from October 2 to 6, 2011.

The 21st century is called "the age of water." Securing safe and sufficient water supplies and creating suitable water environment have become urgent issues worldwide. The Asia-Pacific region, also, needs to maintain and develop its sound water supply and recycling systems with the increasing population and the accelerating urbanization.

Under these circumstances, the main theme of the 4th IWA-ASPIRE Conference has been set as "Toward Sustainable Water Supply and Recycling Systems." We believe that this conference will provide great occasions for experts in all water-related sectors including governments, academics, utilities and industries to gather together for making beneficial presentations and discussions in various fields in a timely manner and actively communicating with the various parties concerned. There will be session meetings, poster sessions, and workshops. Moreover, social events to allow the participants to exchange information in a relaxed atmosphere.

The Exhibition to be held at the same venue will present the latest technologies, products and services in a variety of areas, offering excellent opportunities for business exchanges.

We very much look forward to your participation in the 4th IWA-ASPIRE Conference & Exhibition.

[Co-chairs of the Organizing Committee]

Professor Shinichiro Ohgaki

Dr. Masaru Ozaki

Mr. Yoshihiko Misono

Program Outline

<table>
<tr><th>2011</th><th>Morning</th><th colspan="2">Afternoon</th><th>Evening</th></tr>
<tr><td>2 October (Sun)</td><td>Workshop [Young Water Professionals Program]</td><td colspan="2">Workshop [Young Water Professionals Program]</td><td>Welcome Reception</td></tr>
<tr><td rowspan="3">3 October (Mon)</td><td rowspan="3">Opening Ceremony
Keynote Speech</td><td colspan="2">Session</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Poster Session</td></tr>
<tr><td colspan="2">Exhibition</td></tr>
<tr><td rowspan="4">4 October (Tue)</td><td>Session</td><td colspan="2">Session</td><td rowspan="4">Conference Dinner</td></tr>
<tr><td>Poster Session</td><td colspan="2">Poster Session</td></tr>
<tr><td>Special Workshop</td><td colspan="2">Special Workshop</td></tr>
<tr><td>Exhibition</td><td colspan="2">Exhibition</td></tr>
<tr><td rowspan="3">5 October (Wed)</td><td>Session</td><td>Session</td><td rowspan="3">Closing Ceremony</td><td rowspan="3"></td></tr>
<tr><td>Poster Session</td><td>Poster Session</td></tr>
<tr><td>Exhibition</td><td>Exhibition</td></tr>
<tr><td>6 October (Thu)</td><td colspan="3">Technical Tours</td><td></td></tr>
</table>

Call for Papers

Key Dates

Abstract Submission Open
Early October, 2010

Abstract Submission Deadline
January 31, 2011

March 31, 2011 **Authors notified of acceptance**
June 15, 2011 **Full paper submission deadline**
June 30, 2011 **Early bird registration deadline**

Abstract Submission Information

① Language

English

② Maximum Number of Words

500 words or less

③ Points to Note in Preparing Abstract

Abstracts are to be text only – no tables, diagrams, photographs, etc.

④ Conference Topics

Please select the field from below, and submit the abstract according to the chosen field.

(1) New Vision, Governance and Regulation
(2) Environmental Issues and Sustainability
(3) Environmental Sanitation and Health Related Issues
(4) Risk Management
(5) Finance and Efficient Management
(6) Education, Training and Capacity Building
(7) Customer Service / Communication
(8) Improvement of Revenue Water Ratio (Non Revenue Water Reduction, Leakage Prevention)
(9) Maintenance and Renewal of Facilities
(10) Instrumentation and Operation
(11) Water Quality Management
(12) Drinking Water Treatment
(13) Water Distribution and Supply Systems
(14) Wastewater Treatment
(15) Sewage and Industrial Wastewater Collection, Treatment and Management
(16) Small Scale Treatment Systems
(17) Water Reuse, Rainwater Harvesting
(18) Water Quality Monitoring and Modeling
(19) Water Resource Management and Protection
(20) Watershed Management and Eutrophication
(21) Wetland Systems
(22) Sludge Management and Resources Recovery

⑤ Abstract Submission Deadline

January 31, 2011

⑥ Abstract Submission Guidelines

- Abstracts are to be submitted online. Please follow the submission guidelines on the website-
  http://www.aspire2011.org/abst.html
- Abstracts can be submitted as “oral” or “poster”. Please note abstracts submitted as “oral” may get accepted as poster after peer review;Oral and poster presentations will be regarded equal status.

⑦ Others

- Non-members of IWA may be welcomed to submit abstracts.
- You may submit more than one abstract.
- You may amend or withdraw abstracts online until the submission deadline.
- Obtain consent from co-authors prior to submission.
- The official language of the conference is English. No simultaneous interpretation service will be available.

Presentation Selection

- Abstracts will be selected based on logicality, originality, novelty and benefit, etc.
- Papers for the purpose of advertising products will not be accepted.
- The decision on acceptance or non-acceptance will be made by the 4th IWA-ASPIRE Program Committee.

Events Following Abstract Submission

- When contributors are notified of their tentative selection into the program, they will be notified of the type of presentation they will be invited to give (i.e.“oral” or “poster”).
- For an oral presentation, please submit a full paper (eight A4 pages or shorter including all references, tables and figures) on or before the deadline (June 15, 2011).
- For a poster presentation, submission of a full paper is optional. Please submit a full paper, however, if the presenter wishes to publish the paper in IWA journals, etc.
- All the full papers accepted will be published on proceedings to all delegates who attend the conference other than the collection of abstracts.

Outstanding Papers

① Publication in Journals, etc.

Selected oral and poster papers, will be published in the following media after peer review:

- IWA journals
  - Water Science and Technology
  - Water Science and Technology : Water Supply
  - Water Practice and Technology, etc.
- “Journal of Water and Environment Technology,” electronic journal in English of the Japan Society on Water Environment

② Awards

- A student competition will be organized for the Best Student Awards.
- A poster competition will be organized for the Best Poster Awards.

For Call for Papers Information

The 4th IWA-ASPIRE Call for Papers Desk
c/o Japan Convention Services, Inc.
TEL : +81 3 3500 5935 (Mon.-Fri./9:30-17:30 JST)
FAX : +81 3 5283 5952
E-mail : abstract@aspire2011.org

Dr. Yasumoto Magara [Japan]

President, Educational Foundation Tokiwamatsu Gakuen
Visiting Professor, Center for Environmental Nano and Bio Engineering in Hokkaido University

Yasumoto Magara is a president of the educational foundation of the Tokiwamatsu. He has been an appointed professor of the school of Public Policies of Hokkaido University and was a Professor of Risk Management Laboratory of a graduate school of Engineering, Hokkaido University, where he has been on faculty since 1997. He was admitted to Hokkaido University in 1960 and received the degree of Bachelor of Engineering in Sanitary Engineering in 1964 and Master of Engineering in 1966. After working for the same university for 4 years, he moved to National Institute of Public Health in 1970. He served as the Director of the Institute since 1984 for Department of Sanitary Engineering, then Department of Water Supply Engineering. In the meantime, he was also obtained the Ph.D. in Engineering from Hokkaido University in 1979 and was conferred Honorary Doctoral Degree in Engineering from Chiangmai University in 1994. Since 1964, his research subjects have been in environmental engineering and have included advanced water purification for drinking water, control of hazardous chemicals in drinking water, planning and treatment of domestic waste including human excreta, management of ambient water quality, and mechanisms of biological wastewater treatment system performance. He has also been the member of governmental deliberation councils of several ministries and agencies including Ministry of Health and Welfare, Ministry of Education, Environmental Agency, and National Land Agency. He meanwhile performs the international activities with JICA (Japan International Cooperation Agency) and World Health Organization. As for academic fields, he plays pivotal role in many associations and societies, and has been Chairman of Japan Society on Water Environment.

Professor Magara has written and edited books on analysis and assessment of drinking water. He has been the author or co-author of more than 100 research articles.

SPEAKER

Prof. Zuwhan Yun [Korea]

Professor, Department of Environmental Engineering, College of Science & Technology, Korea University
Chairman, IWA Korean National Committee

Zuwhan Yun holds a B.S. in Civil Engineering and a M.S. in Environmental Engineering from Korea University in Seoul, Korea and a Ph.D. in Environmental Engineering from Polytechnic-New York University in 1988. He is a professor (1991~) of Department of Environmental Engineering at Korea University and the director of The Institute of Environmental Technology and Sustainable Development at Korea University.

As the president (2007~2009) of Korean Society on Water Quality (KSWQ), he organized various academic conferences and industry forums to stimulate water industry in Korea. The efforts lead to form the Korean Water Industry Development Group under the umbrella of KSWQ. He is the chairman of the IWA Korean National Committee.

Recent professional activities include;

Advisory Committee of the Ministry of Environment, Korea (2009~), Management Advisory Council of K-Water (2009~), Water Quality Committee for 4-River Restoration Project (2009~), National Commission on Sustainable Development (2009~2010), Organizing Committee of C40 Climate Leadership Group in Seoul (2008~), and Organizing Committee of IWA's World Water Congress at Busan 2012.

In 2010, Prof. Yun was the recipient of *the Order of Red Stripe Service Merit* from the Republic of Korea for excellence in water environment research and contribution to water industry in Korea. He is the principal organizer of oncoming 5th IWA-ASPIRE 2013 at Daejeon, Korea.

SPEAKER

Dr. Glen T. Daigger [USA]

President, International Water Association (IWA)
Senior Vice President and Chief Technology Officer, CH2M HILL

A recognized expert in wastewater treatment, especially the use of biological processes, Dr. Daigger is currently a Senior Vice President and Chief Technology Officer for CH2M HILL where he has been employed for 31 years. He also served as Professor and Chair of the Environmental Systems Engineering Department at Clemson University. As the author or co-author of more than 100 technical papers, four books, and several technical manuals, he has contributed to advancing practice within our profession. He is President of the International Water Association (IWA). For the Water Environment Federation (WEF) he has served as Chair of several committees, including the task force that developed the most recent edition of the WEF MOP No. 8, *Design of Municipal Wastewater Treatment Plants*, Board of Editorial Review of *Water Environment Research*, the Technical Practice Committee, and the Committee Leadership Council (CLC). He has also served as in the House of Delegates and the Board of Trustees. For the Water Environment Research Foundation (WERF) he served on the Board of Directors and Research Council where he served as its chair. He is the recipient of numerous awards, including the Kappe and Freese lectures and the Harrison Prescott Eddy, Morgan, and the Gascoigne Awards from WEF. A member of a number of professional societies, Dr. Daigger is also a member of the National Academy of Engineers.

SPEAKER

Young Water Professionals Program

The IWA Young Water Professionals (YWP) Program provides professional development and networking opportunities to young professionals and students in the water and wastewater sector basically under the age of 35. The activities and initiatives of the Young Water Professionals' program create opportunities for young members to become more involved in the association providing a platform for them on an international stage. At the 4th IWA-ASPIRE Conference, the YWP program will be hosting sections on the challenges facing young water professionals wishing to be engaged in working for Asia-Pacific water sustainability.

Special Workshop

Special workshops will be held on timely topics during the 4th IWA-ASPIRE Conference.

Exhibition

There will be an exhibition at the same venue in conjunction with the 4th IWA-ASPIRE Conference. The Exhibition will be a good opportunity for information exchange and transmission, as it will be visited by delegates as well as the public. The committee is now inviting exhibitors.

For Exhibition Information

The 4th IWA-ASPIRE Exhibition Desk
c/o Japan Convention Services, Inc.
TEL : +81 3 3508 1246 (Mon.-Fri./9:30-17:30 JST)
FAX : +81 3 3508 0820
E-mail : exhibition@aspire2011.org

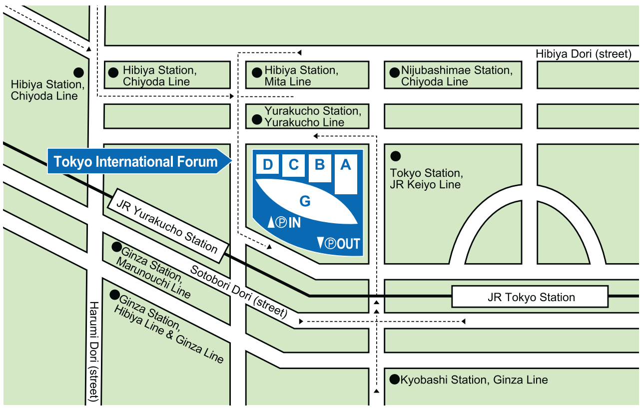
Venue: *Tokyo International Forum*

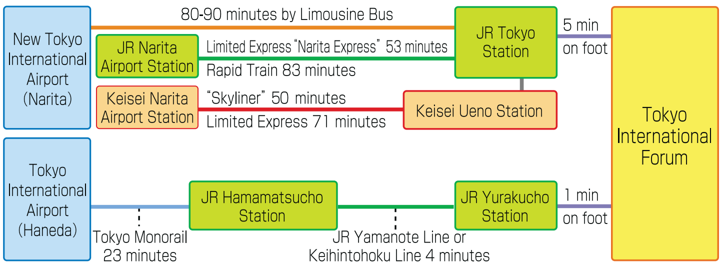
The venue will be the Tokyo International Forum that is attracting visitors from both home and abroad as a landmark of Tokyo. Tokyo International Forum is one of the best quality convention & art center in Japan. It is equipped with 8 halls including a theater-style hall with 5,012 seats, one of the largest in Japan, 34 meeting rooms and gallery. Another appeal is its convenient location. It is close to the central business district Marunouchi, and renowned shopping district Ginza.

▲Tokyo International Forum

▲Lobby Gallery

Access





JR

- 1min. walk from Yurakucho Station
  5min. walk from Tokyo Station
  (connected by B1 concourse with Keiyo Line at Tokyo Station)

Subway

- Yurakucho Line
  (connected to Yurakucho Sta. through underground concourse [Exit D5])
- Chiyoda Line
  5min. walk from Nijubashimae Sta.
  7min. walk from Hibiya Sta.
- Marunouchi Line
  5min. walk from Tokyo Sta.
  5min. walk from Ginza Sta.
- Hibiya Line
  5min. walk from Hibiya Sta.
  5min. walk from Ginza Sta.
- Ginza Line
  7min. walk from Ginza Sta.
  7min. walk from Kyobashi Sta.
- Mita Line
  5min. walk from Hibiya Sta.

General Information

Tokyo-A Metropolis Like No Other

Tokyo, Japan's capital, is a world city equal in sophistication to New York and London. Originally called Edo, the city first began expanding as the power base of the 300-year Shogunate, became the capital and grew into the giant metropolis of today. Japan's transportation networks are centered on Tokyo, and this is the focus of the nation's politics, economy, business, information, culture, and manufacturing. Tokyo is a constantly evolving global metropolis, with a culture that has a worldwide influence.

Tokyo-The Modern and The Traditional

Tokyo is a fascinating contrast of the old and the new: one of the world's most modern cities, it still retains many of its unique cultural traditions and customs from centuries ago. Tokyo's markets import produce from all over Japan and the world, and the city's huge variety of dining choices ranges from traditional Japanese food to authentic cuisines from many lands, and Michelin currently gives Tokyo more stars than any other city in the world. Its numerous and diverse shopping areas include such well-known names as Akihabara, Ginza, Omotesando, Marunouchi and Odaiba. Entertainments available range from traditional attractions such as sumo, kabuki and bunraku to the latest musicals and shows. Unique excursion ideas include hands-on activities such as traditional tea ceremony, flower arrangement and kimono wearing.

Places to Visit in Tokyo

Perhaps the most popular historical site is Asakusa's Sensoji Temple and Nakamise Road, a colorful street of festival stalls which are always bustling with local worshippers and tourists alike. Many UNESCO Intangible Cultural Heritage productions in the world-famous performance arts of kabuki, bunraku, and noh are offered at various theaters. For a truly peaceful experience, one can stop and meditate in the traditional teahouse of leafy Hama-rikyu Gardens.

On the other hand, Tokyo, a megalopolis bursting with ideas and innovation, is full of ultra-modern and glass-walled skyscrapers, like the magnificent Tokyo Metropolitan Government building near Shinjuku Station. Daiba area in Tokyo Bay, the Omotesando Hills complex, Shiodome skyscrapers, and the New Tokyo Tower, due to be completed in 2011, are also symbols of Japan's ever-furthering venture for modernity.

The Ginza and Yurakucho areas, by the conference venue the Tokyo International Forum, are a shopper's paradise where visitors can purchase everything from traditional sweets to latest mode fashion pieces. In Akihabara's "Electric Town," there are multi-storied mega stores and backstreet specialist shops dealing in the latest electronics and coolest pop-culture trends.

▲ Imperial Palace

▲ Sensoji Temple

▲ Ginza

Climate

Autumn starts in September, with nice, cool breezes after the hot and humid summer. It is a very refreshing period. Many leaves turn red and yellow and the temperature at night and in the morning can drop dramatically. The average temperature of October in Tokyo is 21.6℃/ 71°F. Clothing: light jackets, light sweaters.

Electricity

In Japan 2-flat-pin plugs are used instead of columnar-shaped plugs. The voltage used throughout Japan is uniformly 100 volts, A.C. There are two kinds of frequencies in use; 60 Hertz in western Japan and 50 Hertz in eastern Japan. *Tokyo-50 hertz
A convertible type of electrical appliance such as a travel iron, hair dryer, and shaver will therefore be handy. Otherwise, a step-down transformer is required to convert the voltage.

Passport and Visa

Any foreign visitors desiring to enter Japan must have a valid passport. A visa is required for citizens of countries that do not have visa exempt agreements with Japan. Please check the following URL for your VISA requirement and contact the nearest Japanese Embassy or Consulate for visa requirement when you need VISA.
http://www.mofa.go.jp/j_info/visit/visa/index.html

Currency & Foreign Exchange

Japanese money comes in bills (1,000yen, 2,000yen, 5,000yen and 10,000yen) and coins (1yen, 5yen, 10yen, 50yen, 100yen and 500yen). Major currencies including the US dollar, Australian dollar, EURO can be exchanged at major banks and post offices, hotels and other facilities. Banks are open Monday to Friday from 9:00 till 15:00. The range of currencies dealt with varies from facility to facility. Please check with a tourist office or other source of information.

Traveler's Checks and Credit Cards

Traveler's checks are accepted by leading banks, hotels and stores in major cities. International credit cards such as American Express, VISA, Diners Club, MasterCard and JCB are also acceptable at these major establishments. Credit card transactions, however, are not always convenient outside big cities. So obtaining cash beforehand is recommended when you travel to the countryside.

Tip

Tip is not necessary unless you request some extra special service.
Individual tipping is not common in Japan, since a 10 to 15% service charge is added to the bill at leading hotels and higher-class restaurants.

Dining Options

Visitors will find ample opportunities to taste fine Japanese cuisines, such as sushi, tempura, sukiyaki, and kaiseki dishes at reasonable prices; these local treats feature fresh ingredients, delicate flavorings, and spectacular presentation, all while remaining healthful and nutritious. In addition, visitors will be overwhelmed by the sheer range of choices for dining that offers tempting delights from around the world.

Time Zone

Japan is in a single time zone, nine hours ahead of GMT. No daylight Saving Time.

Helpful Websites

- Guide to Japan: **http://www.jnto.go.jp/eng/**
- Japan Weather Information: **http://www.jma.go.jp/jma/indexe.html**
- Currency Converter: **http://www.oanda.com/**
- Trends in Japan: **http://web-japan.org/trends/index.html**

Hotel Information

Following informations are nearby hotels from Tokyo International Forum.
Please refer them when you look for the accommodation.
No registered hotels are available for this conference.

The Peninsula Tokyo
http://www.peninsula.com/tokyo/jp/default.aspx

Imperial Hotel
http://www.imperialhotel.co.jp/j/

Marunouchi Hotel
http://www.marunouchi-hotel.co.jp/

Hotel Metropolitan Marunouchi
http://www.hm-marunouchi.jp/

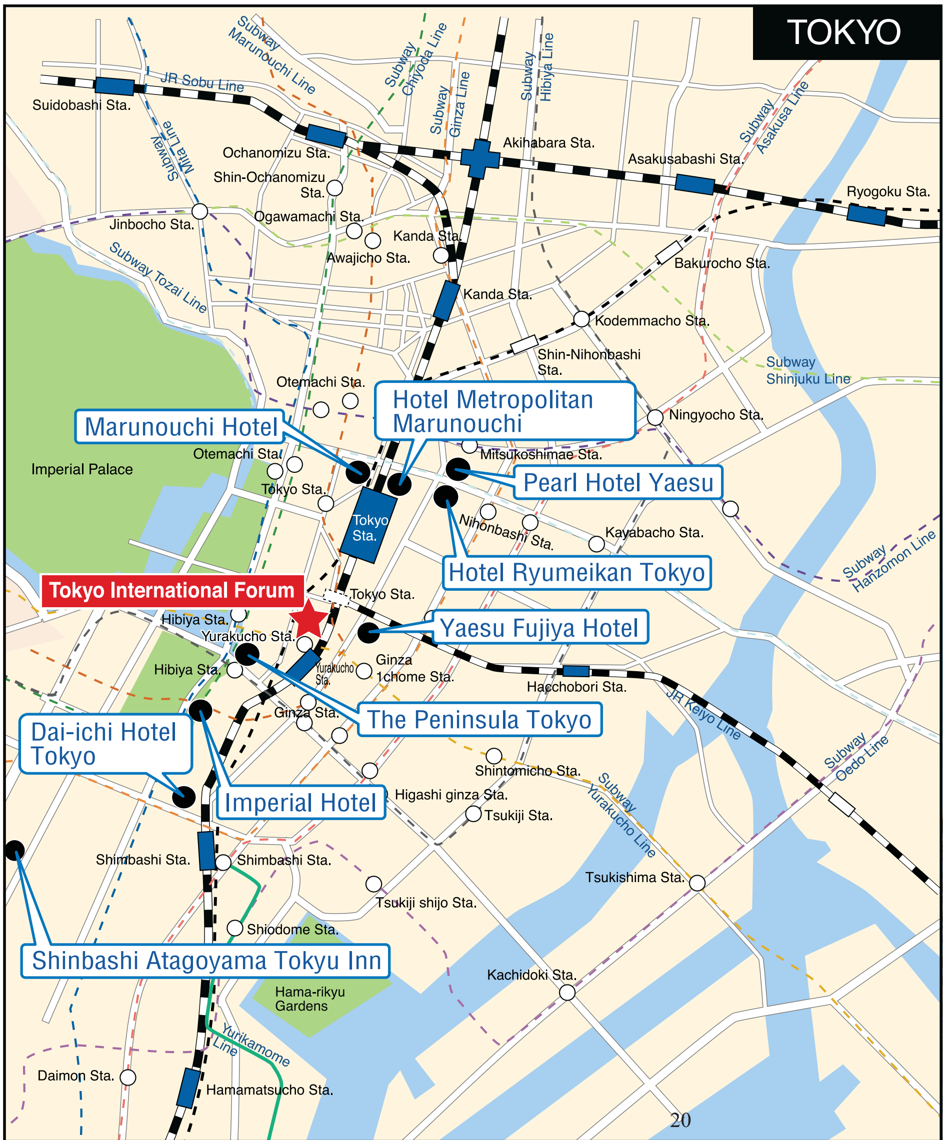
Dai-ichi Hotel Tokyo
http://www.daiichihotel-tokyo.com/cgi-bin2/cms2/index.cgi?hid=05dhtokyo

Hotel Ryumeikan Tokyo
http://www.ryumeikan-tokyo.jp/

Yaesu Fujiya Hotel
http://www.yaesufujiya.com/

Shinbashi Atagoyama Tokyu Inn
http://www.atagoyama-i.tokyuhotels.co.jp/

Pearl Hotel Yaesu
http://www.pearlhotels.jp/yaesu/index.html



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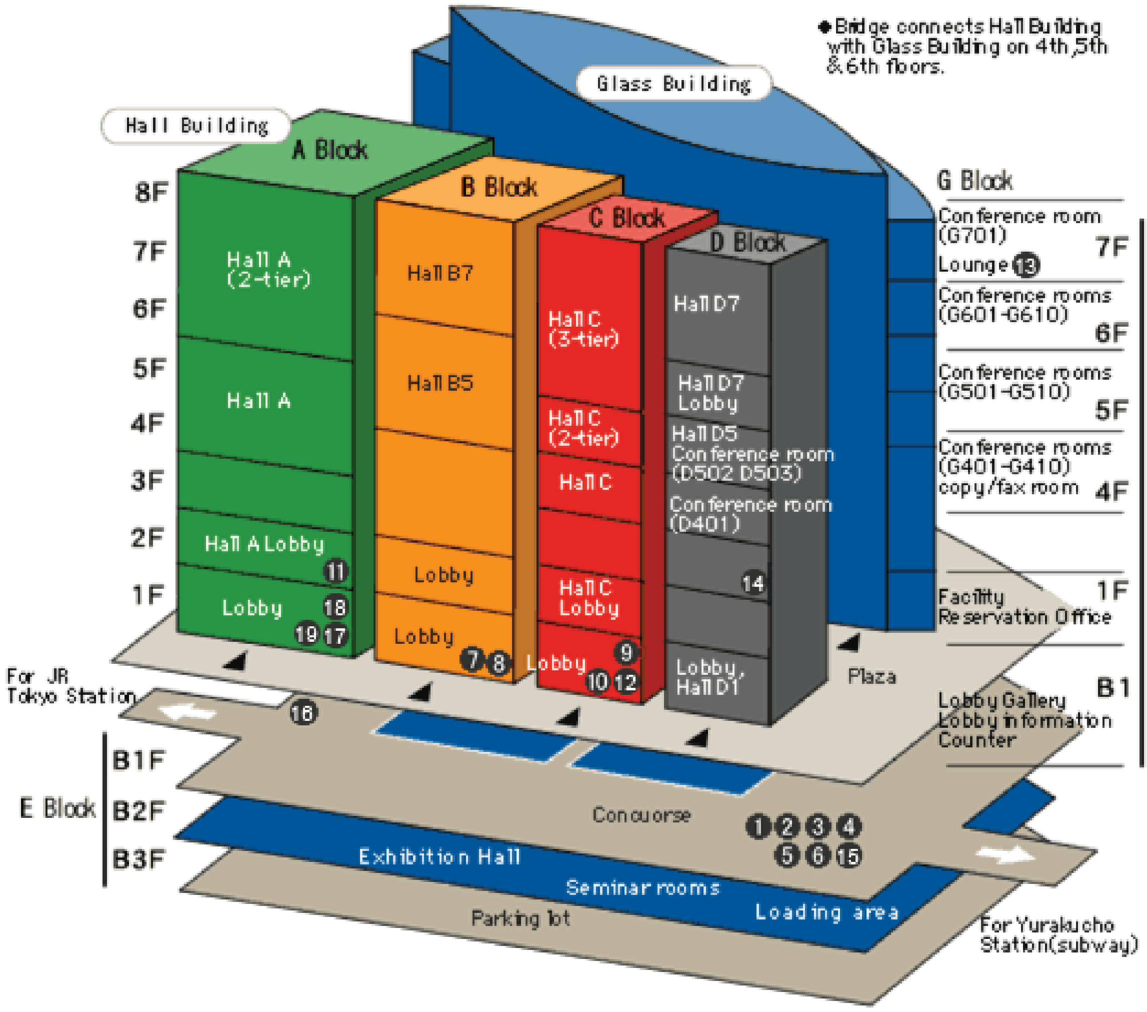
Contact Details

The 4th IWA-ASPIRE Organizing Committee Secretariat
c/o Japan Convention Services, Inc.
Daido-Seimei Kasumigaseki Bldg.18F
1-4-2 Kasumigaseki Chiyoda-Ku Tokyo 100-0013 Japan
TEL : +81 3 3508 1246 FAX : +81 3 3508 0820
E-mail : inquire@aspire2011.org Website : www.aspire2011.org

附錄 2

行程表

日期	星期	事由	行程	備註
10/2	日	啟程及揭幕式	台北→東京	
10/3	一	研討會及展覽	東京	
10/4	二	研討會及展覽	東京	
10/5	三	研討會及展覽	東京	
10/6	四	技術參觀及返程	東京→台北	



◆Bridge connects Hall Building with Glass Building on 4th,5th & 6th floors.
Glass Building
Hall Building
A Block
B Block
C Block
D Block
G Block
8F
7F
6F
5F
4F
3F
2F
1F
Hall A (2-tier)
Hall A
Hall A Lobby
11
Lobby
18
19 17
Hall B7
Hall B5
Lobby
Lobby
7 8
Hall C (3-tier)
Hall C (2-tier)
Hall C
Hall C Lobby
Lobby
9
10 12
Hall D7
Hall D7 Lobby
Hall D5
Conference room (D502 D503)
Conference room (D401)
14
Lobby, Hall D1
Conference room (G701)
Lounge 13
7F
Conference rooms (G601-G610)
6F
Conference rooms (G501-G510)
5F
Conference rooms (G401-G410)
copy/fax room
4F
Facility Reservation Office
1F
Plaza
Lobby Gallery
Lobby information Counter
B1
For JR Tokyo Station
16
E Block
B1F
B2F
B3F
Concourse
1 2 3 4
5 6 15
Exhibition Hall
Seminar rooms
Loading area
Parking lot
For Yurakucho Station(subway)

PROMOTE THE RELIABILITY OF WATER DISTRIBUTION SYSTEMS WITH IN TIME MANAGEMENT MODEL OF MONITORING SYSTEMS

Hong-Min Shau*, Ren-Feng Shiau **, Wen-Chi Huang***

*1.Senior Executive Offier in Taiwan Water Supply Corporation. 2.Ph.D., Assistant professor, Department of Industrial Engineering & Management National Chin-Yi University of Technology, Taichung, 41170, Taiwan, R.O.C
(E-mail: hongmin6@gmail.com; hongmin @mail.water.gov.tw)
**Master Candidate, Department of Landscape Architecture, National Chin-Yi University of Technology, Taichung, 41170, Taiwan, R.O.C.
(E-mail: james82000@lsc.net.tw; jammy660723@yahoo.com.tw)
***Ph.D.Professor, Department of Transportation Technology and Management, Kainan University, Luzhu Shiang, Taoyuan 33857, Taiwan, R.O.C
(E-mail: pmishwc@mail.knu.edu.tw).

ABSTRACT

The Maintaining system infrastructure to distribution drinking water to customers is often a significant challenge for the operators of the water supply distribution system. The risk happen in the system, the broken pipe's being not able to be repaired in time often causes being unable to supply water or flow loss, the water pollution, resulting in the users' dissatisfaction.. This research is established the in-time management models with the District Meter Area (DMA) network, monitoring stations, and system control center. That is related to building of the DMA and establishing of the management model with control DMA Network systems, those can find potential leak area or pipes and to replacement before leakage.That also can detect the decrease water pressure and abnormal increase of conductivity ＆leakage in time. Then It use dual check by means of decrease the water pressure, estimate the Minimum Night Flow (MNF) and obtain the water-leaking point from the leak or broken pipe, and repair the pipe promptly. The method can make the water distribution system supply water under the best condition, reasonable water pressure and thus raise the reliability of that system. In this study, the Ruey-Fang DMA network system was chose as case study to verified the model& proposed method, and show increase the efficiency in result.

KEYWORDS

Monitoring system, district meter area, management model, network, reliability

INTRODUCTION

The Water Department are paying more and more attention to control＆management of water systems, including the water quality, the leakage, the water pressure, and the water quantity. The raising of the reliability of water distribution system is needed. Although research has completed on potential leak area or pipes and to evaluate the minimun leakage in each zone of water distribution systems. In this study, the in time monitoring management information system was constructed in the DMA＆the monitoring stations. That monitoring stations setup by the arc line method and coverage area.The pipe may break and the pollutant intrude at any time and at any point in the system, the grasp of the time difference is very important and quiet difficult in simulation. Moreover, in the entire course of operation, the monitoring station and the operators of the control system shall maintain the conditions of normal operation and respond and handle the incidents in time, which is the most important base of existence of this control system by the management models with DMA network. Therefore, establishment of "the continuous arc line" and "the first arc line" in the network, in the past operating information of the shortest path's length and data, the monitoring station's coverage, and the hydraulic simulation model can be controlled and inputted in the system. It makes the monitoring station be able to control the water pressure, the minimum minnight flow, leakage estimation techniques, and perform mathematical calculations the unreliability pipe and postion of the burst pipe or the source of pollution due to abnormal situations, and it can repairt the pipe in time. That make the DMA network system to achieve the best condition, and raising the reliability.

MATERIALS AND METHODS

The System Reliability

Goulter and Coals (1986) and Suetal.(1987) used the probability theory of failure rate of each pipelines. Use that theory to complete the DMA reliability of the system, That calculate lower reliability area and repairt the pipes to make the system achieve the best condition, and raising the reliability. The probability of failure of pipe i , P_i, is determine using the Poison probability distribution

$$P_i = 1 - e^{-\beta_i} \qquad (1.1)$$

and $$\beta_i = r_i L_i \qquad (1.2)$$

whereβj is expected number of failures per year for pipe i; r_i is expected number of failures per year per unit length of pipe i; and L_i is length of pipe i.

The system reliability Rs, is obtained from minimum cut sets. Su et al.(1987) defines the minimum cut set as "a set of system components, when failed, causes failure of the system." Supposing there are n pipelines in the ith minimum cut set of a water distribution network system, the failure probability of the ith minimum cut set (MC_i) is

$$P(MC_i) = \prod_{j=1}^{n} P_j = P_1 * P_2 \ldots * P_n \qquad (1.3)$$

For example, there are 4 minimum cut sets: MC_1, MC_2, MC_3 and MC_4 in the water distribution network system. Billinton and Allan (1983) defined the failure probability P_f of the system's reliability as follows:

$$P_f = P(MC_1 \cup MC_2 \cup MC_3 \cup MC_4) \qquad (1.4)$$

Applying the union and intersection principles of Ross (1985) to define the above-mentioned, the equation P_f can be simplified to be:

$$P_f = P(MC_1) + P(MC_2) + P(MC_3) + P(MC_4) \qquad (1.6)$$

$$P_f = \sum_{i=1}^{4} P(MC_i) \qquad (1.7)$$

In general form

$$P_f = \sum_{i=1}^{M} P(MC_i) \qquad (1.8)$$

Then the system reliability R_f can be represented as:

$$R_i = 1 - P_f = 1 - \sum_{i=1}^{M} P(MC_i) \tag{1.9}$$

where M is the number of minimum cut sets in the system. The same research method can be used on the analytic method of calculating the node’s reliability.

The Series Connection System Reliability

The simplest and the most typical system is the series connection system. Each water distribution network will function when the system operates. The ith water distribution network: the random variable that considers the time failure is Ti; for the water distribution network(s) in the system, the system's reliability is

$$R_s = \prod_{i=1}^{n} R_i \tag{1.10}$$

R_i is the reliability of the i^{th} water distribution network.

It comprises a string of pipes. If there is any pipeline leaking, the entire system can not operate. The model is based on the chain concept of n numbers. If the applied pressure x exceeds the intensity of any chain pipeline y, the chain will be broken and will leak. The model is applicable for the weakest chain model. Its system's reliability is

$$R_S = \min_i \{R_i\} \tag{1.11}$$

The equation of reliability of any chain pipeline is

$$R_i = P(x < y_i) = \int_0^{\infty} f_{yi}(y)\, F_x(y)\, dy \tag{1.12}$$

The Management Models with control DMA Network

The Management Models with water distribution network(s) in the water supply controal center system, Utilize the covering area and the arc line method of the DMA to get adopted monitoring stations for the management models. It is an effective way to evaluate water pressure,the quantity by hydraulic model and the setting sites of the adopt monitoring stations. The effective auditing mechanism of the monitoring stations in DMA, which make use of the Minimum Night Flow (MNF) method to evaluate of a long-term leakage in DMAs by TSDI (Time Series Data Interface) , and the pipelines' abruptly breaking time, location, distance, and path with the hydraulic simulation model. The messages of the internet, wireless telecommunication technology, SMS (Short Message Service),and Public Switched Telephone Network(PSTN) system, and monitoring points in order to achieve the effective and resonable water pressure ,quantity ,in results. The management models with the water supply controal center shown in Figure 1.

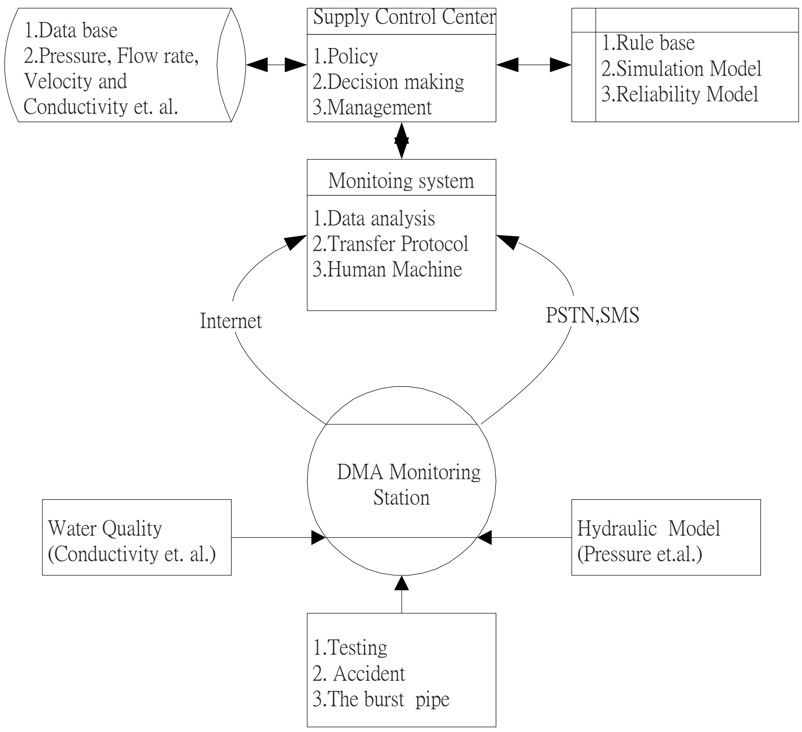


Figure 1 The Management Models with the Water Supply Controal Center System

According the system reliability to analysis the relation methode and considerations are as follows:

1. Unreliability Pipeline and arc line to solve by the monitoring stations with DMA. The methode used the network weakness reliability analysis to find out the areas with the high leakage potential and pipe replacement. This analysis produces unreliability area and pipes which quantified the leakage by depicted , revealing the most critical area and pipes. It makes DMA setting along with pipeline replacement focus on the key places to effectively decrease the leakage.
2. Which estimation techniques to evaluate the leakage of each zone of pipe replacement in DMAs, the Minimum Night Flow(MNF) method is generally adopted. Usually, MNF is not exact the leakage in the DMA although it s economy and fast. The inaccuracy of MMF becomes its bottleneck. as shown in Figure 2. We applied principles of probability and statistics to simulate the water consumption behavior of users in pass time and established the predict Intake Probability Model of users' meters with binominal distribution. This can be used to the leakage of DMA from flow signals of electromagnetic meters along with MNF method.
3. According to pass data can execute the conductivity, the water pressure, the water quantity& MMF in the DMA monitoring stations. That analysis determine the reasonable water pressure, quantity,to control it's uniformity and whether leakage in DMA.by its method.
4. If the burst pipe and the pollution in the water distribution network can happen at any place and any time. The time monitoring system of DMA can control and be read in the data ,Also records it. The burst pipe makes the water pressure decline suddenly, the water quantity raise abruptly, the pollutant intrude the water distribution system, and the conductivity increase. These incidents are caused at the continuous connecting points, not happening in the discontinuous situation.

5. In theory, water pressure and leakage flow relations FAVAD easiest type equation〔 $L_1/L_0 = (H_1/H_0)^{\eta}$ 〕Reasonable water pressure, The management models can control DMA Network in reasonable water pressure(H^{η} ,η), That changs by the maximum hours , minimum hours and abruptly variable discharge flow.as In general, joints and other parts can not test the small leaks and plastic leaking or burst pipe or large leaks of its η value is generally compared to 1.5. The metal pipe may be leaking or burst pipe to detect the η value was 0.5. Figure 3 shows the η value relative to the relationship between water pressure and leakage rate,Which the monitoring system can execute control the water pressure and quantity in DMA.

6.The probability of each connecting point to become the burst pipe or a source of pollution is equal, but only one connecting point acts at a time as the burst pipe or the source of pollution. The methode can find the leakage point of pipes and repaire it immediately.

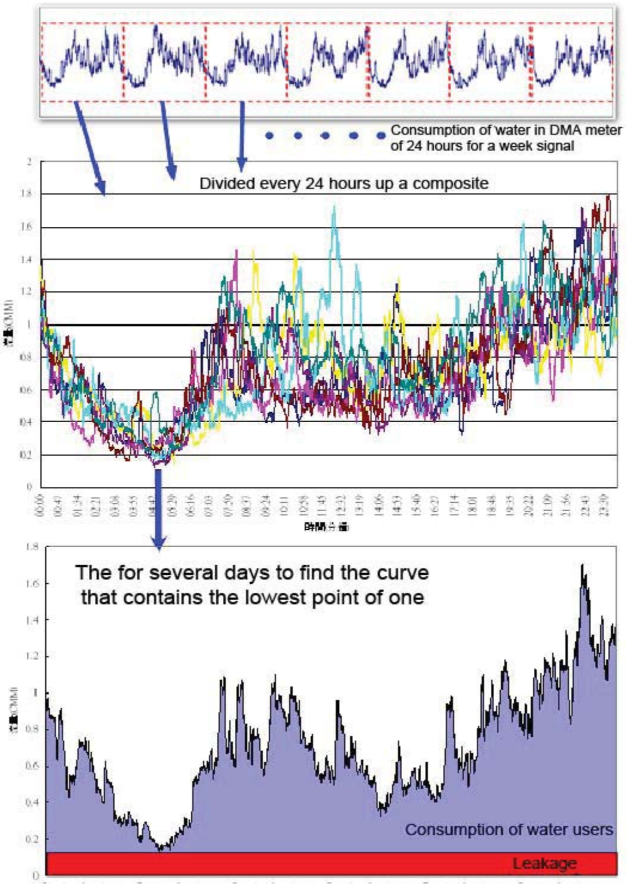


Fig. 2.The leakage of DMA in Bottleneck by Minimum Minnight Flow Method

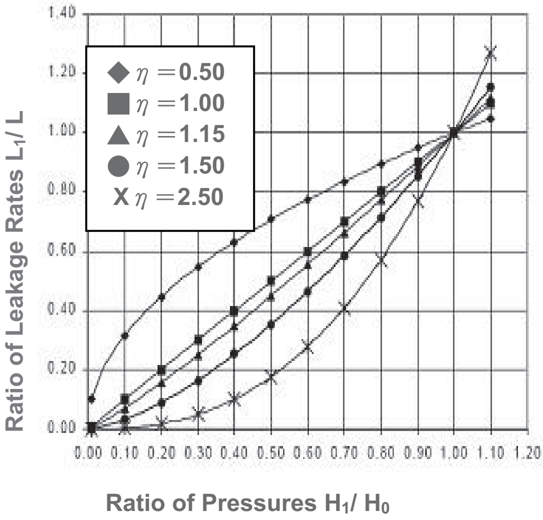


Fig. 3. Leakage(L) is proportional to the water pressure(H^{η})

CASE STUDY AND DISCUSSION

In order to test the raising reliability in water distribution system. The in-time management models with control DMA Network with monitoring system are built in the Ruey-Fang water supply system in New Taipei City. We adopt the Ruey-Fang DMA network as case study to do the research, shown in Figure.4. Figure.4 is the System hydraulic analysis chart of the Ruey-Fang DMA network (maximum hour). We take the results and the discussion as fellows.

In the case of the Ruey-Fang DMA network

There are 26 pipelines, 20 nodes, and 2 water intake points. One of intake is water treatment plant; the other is the Kung-Liao system support. The maximum water-consuming amount of the entire district is 15,480CMD, and the minimum is 5,710CMD.

Method Description

The solution solved by the minimum covering method is four monitoring stations and control leakage of the Ruey-Fang DMA by the monitoring station control method, as fellow:

calculate velocity and duration.

Refer to Figure 5 for the monitoring stations. Use the auxiliary network established by simulation model to calculate the flow velocity and duration at each node.

Conduct network analyses

Comparison between the abnormal conductivity ,Minimum Minnight Flow ,and the reduced water pressure measured at each monitoring station with normal operation records of the previous conductivity ,Minimum Minnight Flow , and the water pressure in order to estimate the location of damaged or burst pipes.

detect the leakage

The real time monitoring station transfer the detective data as showed in Figure 5 and Fig.6. We try to look for leakage of the Ruey-Fang DMA by MMF control method. Now close the valve tight community within the DMA, with only a water if the flow is greater. Which is have leaking pipe and then open the local valve of the DMA has suddenly closed intake valve . Than to make negative pressure test by the valve-closed of the MMF,we can know increase conductivity in monitoring stations, check on the system conductivity of the station can detect the leakage point in the DMA.

For the variation of the water quantity, the water pressure, and the conductivity in the node of number 17 monitoring station. We can find the water pressure is lower and conductivity higher than normal value and another nodes (show in Figure 6)is correct, so we know this 17 node covers district have pipes break down. We get Tc – Tp＝0.07hours. The location of the burst pipe is calculated: Lij = C Vij (Tc – Tp), Lij＝140meter then node15 is normal, so form arc line analysis the pipe break down between nodes 10-17 and distances node17 is 140meter.

Reliability increased analysis
According item's (4) analysis, The burst pipe repair time form beginning to repair it need one day and depend on record analysis that repair time is seven days normally, so it's reliability increase 2% .

Analysis failure probability
As showed in Table 1 and Figure 4, that the failure rate for pipes in Ruey-Fang area has a strong relationship with pipe diameter. Table 3. is failure probability for Ruey-fang system.

Promotion reliability
For the in-time management models with monitoring system and control stations in Ruey-fang system, As showed in Table 1 , that the failure rate for pipes in Ruey-Fang the DMA and Fig. 4,Fig. 6, showed the water flow's path and time diagram of monitoring stations. It's DMA used the network weakness reliability analysis, As showed in Table 1 from 2000 to 2002,That data finds diameter 100m/m,150m/m and 200m/m pipes to have the high leakage potential. So renews the pipes by DIP and use MMF control method from 2003 until now. Then take Minimum Minnight Flow of Ruey-Fang DMA network monitoring station according to whether the control information leakage and water according to the past to determine the reasonable water pressure and control water pressure within the Ruey-Fang DMA network uniformity. The methode to effectively decrease the leakage from 2005 to 2009, As showed in Table 2.

Renew the pipes and management model promote efficiencys analysis
Form Table 3. is failure probability for Ruey-fang DMA from 2000～2002 to2005～2009 was decreased 0.2032,Enhance the reliability was increased 75.82%. So that the management models with control DMA Network promote the efficiency reliability was increased Ruey-Fang water distribution system.

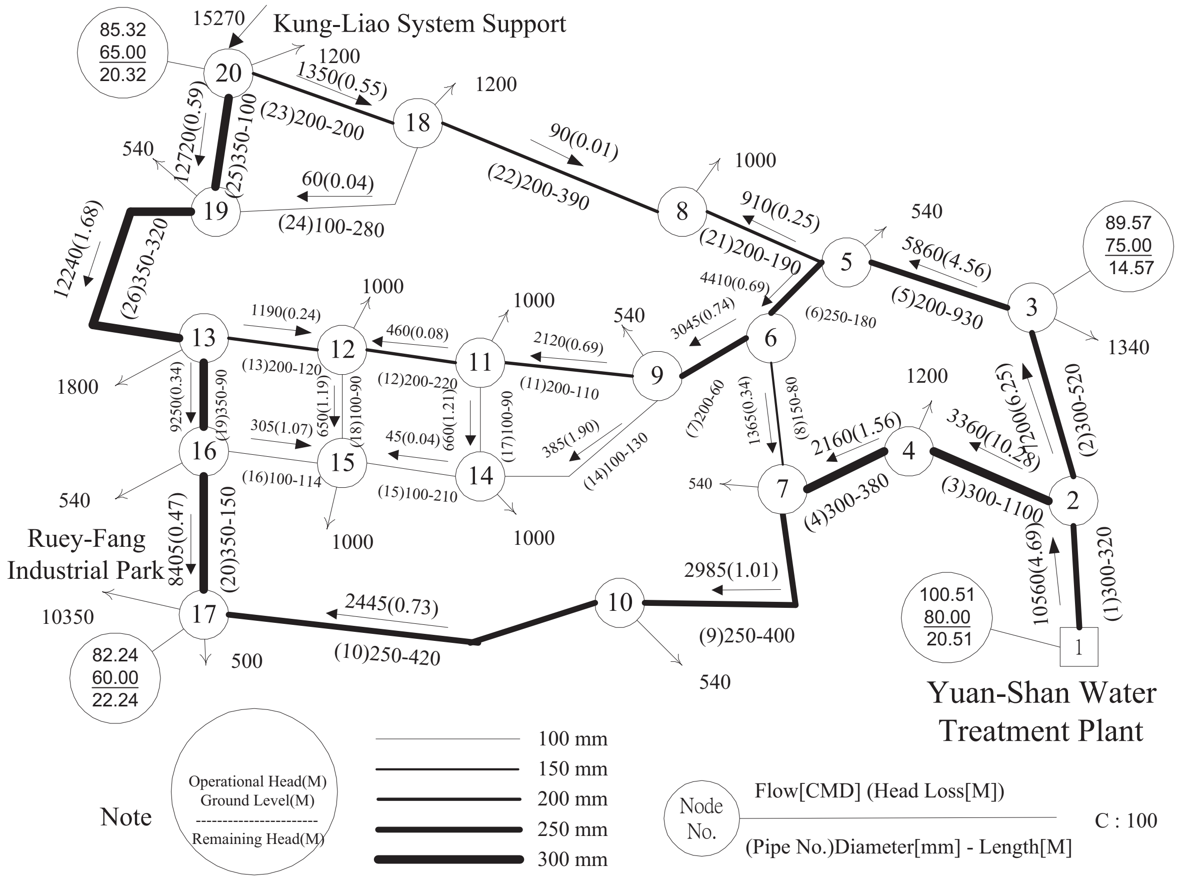


Fig 4. System hydraulic analysis chart of Ruey-Fang DMA network(maximum hour)

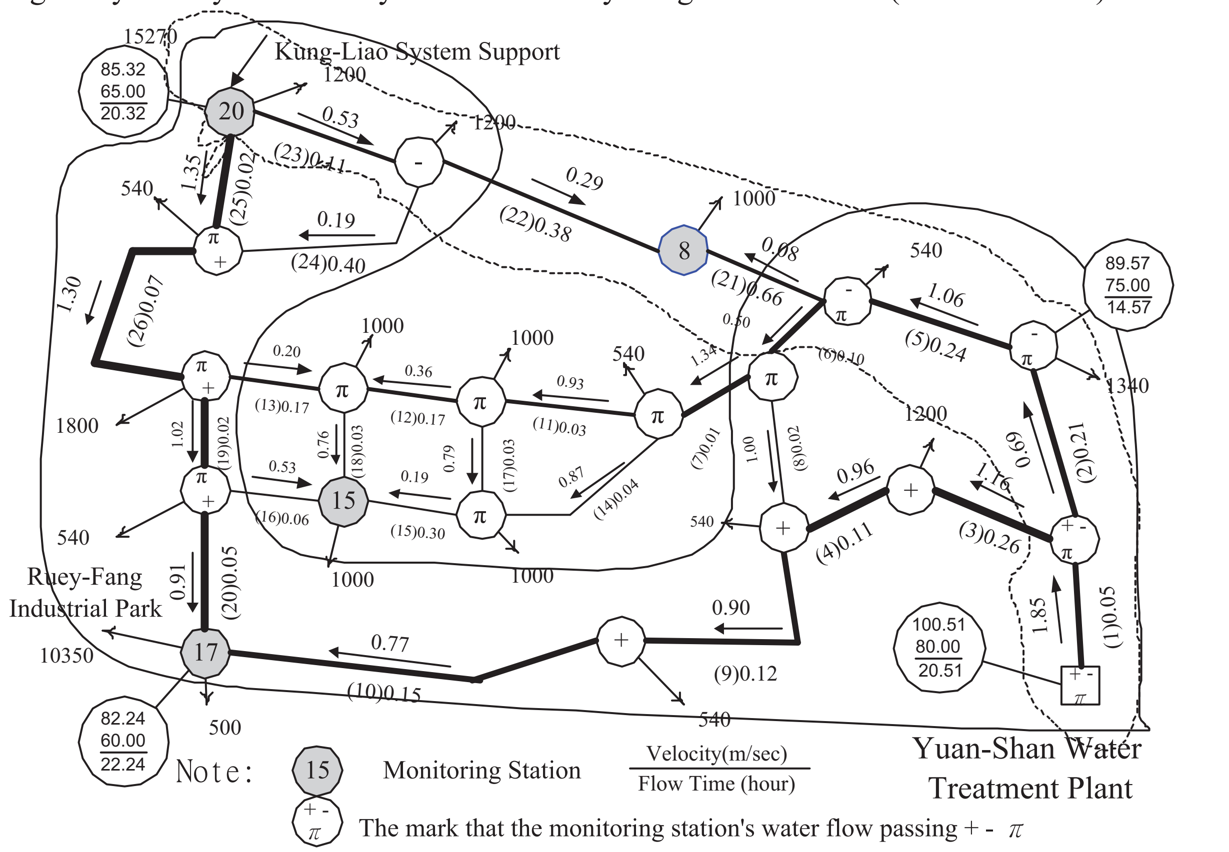


Fig.5. Water flow's path and time diagram of monitoring stations in Ruey-Fang DMA network.

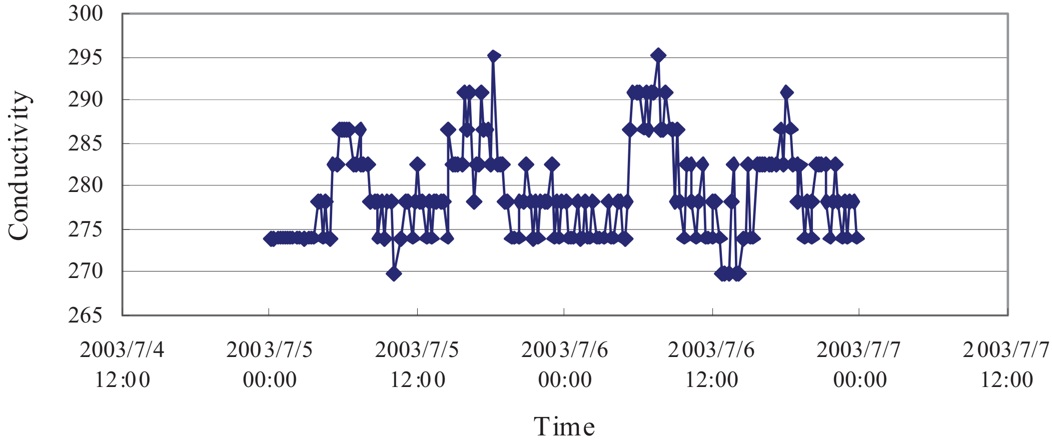


Fig.6. The real time monitoring of conductivity in Ruey-Fang DMA network street station.

Table 1 The calculation pipes of break rate form 2000 to 2002 in Ruey-Fang DMA network

Diameter (m/m)	Pipe length (m)	Breaks (From2000 to 2002, 3 year)	Break Rate (breaks/kilometer/year)
100	8357	71	2.832
150	6716	25	1.241
200	1857	10	1.795
250	5629	6	0.355
300	5884	3	0.170
350	4100	15	1.220

Table 2 The calculation pipes of break rate form 2005 to 2009 in Ruey-Fang DMA network

Diameter (m/m)	Pipe length (m)	Breaks (From2005 to 2009, 5 year)	Break Rate (breaks/kilometer/year)
100	8357	0	0.000
150	6716	7	0.208
200	1857	1	0.180
250	5629	8	0.284
300	5884	3	0.102
350	4100	0	0.000

Table 3. The failure probability for Ruey-Fang DMA network.

Pipe Number	Length (rn)	Diameter (mm)	Failure Probability		Pipe Number	Length (rn)	Diameter (mm)	Failure Probability	
			2000～2002	2005～2009				2000～2002	2005～2009
1	320	300	0.0529	0.0321	15	210	100	0.3857	0.0000
2	520	300	0.0846	0.0517	16	114	100	0.2759	0.0000
3	1100	300	0.1706	0.1061	17	90	100	0.2250	0.0000
4	380	300	0.0626	0.0380	18	90	100	0.2250	0.0000
5	930	200	0.8116	0.1541	19	90	350	0.1040	0.0000
6	180	250	0.0619	0.0498	20	150	350	0.1672	0.0000
7	60	200	0.1021	0.0107	21	190	200	0.2890	0.0336
8	80	150	0.0945	0.0165	22	390	200	0.1034	0.0678
9	400	250	0.1324	0.1074	23	200	200	0.3016	0.0354
10	420	250	0.1385	0.1124	24	280	100	0.5475	0.0000
11	110	200	0.1795	0.0196	25	100	350	0.1149	0.0000
12	220	200	0.3263	0.0388	26	320	350	0.3189	0.0000
13	120	200	0.1938	0.0214	Total Length	7194	Weighted average	0.2680	0.0648
14	130	100	0.3080	0.0000	Increase reliability		75.82%		

CONCLUSIONS

Setup advanced control model

The DMA network along with establishment of the monitoring system and the optimal allocation can be obtained and proven in this study. The establishment of the in-time the management model with control DMA network can detect the decrease water pressure and abnormal increase of conductivity, the water quantity, which evaluate minimun leakage in the water supply distribution from the monitoring station and leak positioning system. It will be increases the reliability of water supply system and prevents the pipes to be broken. In addition, the study develops a more advanced control model directed towards the reasonable water pressure and quality through the monitoring stations deployed within the range of piping arc lines in the water supply system.

Increase the model efficiencys

Use the model in this research to set up monitoring stations and control center for the maximum performance and the minimum cost. Abnormal status of the water supply system can be revealed through measuring and comparing day and night. In addition, Find the potential leak area ＆pipes emergency repair can be conducted to decrease leaking and water supply suspension duration as well as to prevent water quality from deteriorating and to provide more reliable water supply to users. In the case of the Ruey-Fang DMA network system which reliability was increased 75.82% from 2005 to 2009, the residents in the Ruey-Fang DMA network suffered serious drought and experienced water shortage and water rationing

Benefits both maintenance and management

The management information system with monitoring system set up by the multi-stage system with various selective items can take design requirements for practical engineering into consideration completely. Conducting a case study on the Ruey-Fang DMA network system benefits both maintenance and management of the water distribution network.

Applied to designing the monitoring station

When the optimized model is applied to designing the monitoring station of a local area water distribution network, different flowing directions at various times need to be attended to. The water pressure, the water quantity, and the conductivity amount can be measured in detail by a recorder. A direct proportional relationship exists among them, which can be compared with abnormality and thus increases stability of water supply relatively.

Increase the customer satisfaction

This method, which region-wide water distribution center system can linking by the Central Water Analysis laboratory, an SCADA &GIS, timely response to the Customer service call center and meet development needs of the user in systems. That set up the best water supply control center to meet the increasing demand for customer satisfaction after a day.

In the future

How to reduce the minimum min-night flow(minimum leagate) is another research direction (such as reducing tube's joints, pipe residue, cecal tube, etc.). In the future, Also water works will use inside ,outside, resources and combine the arts, humanities with science , the cloud&technology resources and ecological concepts to make sustainable development.

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Adaptation Strategies to Climate Change for water supply : The experience of Taiwan Water Corporation

Tin-Lai Lee*, Yu-Zen Chen*, Nan-Tzer Hu**

*Department of Water Supply , Taiwan Water Corporation, No2-1, Sec.2, Shuang Shih Rd., Taichung City, 40425, Chinese Taiwan (E-mail: *tinlai@mail.water.gov.tw*)
** Vice President, Taiwan Water Corporation, No2-1, Sec.2, Shuang Shih Rd., Taichung City, 40425, Chinese Taiwan (E-mail: *nantzerhu@mail.water.gov.tw*)

Abstract
Climate change caused extreme changes in Taiwan's hydrological cycle, it also affect the function and safety of water infrastructure and deteriorated water supply stability. Global warming can no longer be avoided and the future will face sea level rise, increase intensity of typhoons and rainstorms, droughts, the crisis on water supply. Therefore, how to live with climate change wisely is an unavoidable challenge for water industries in the world. The purpose of this paper is to describe the experienced mitigation and adaptation strategies that Taiwan Water Corporation has adopted to cope with climate change.

Keywords
adaptation strategies; climate change; global warming; water supply stability

INTRODUCTION

Climate change is now widely recognized as a major environmental challenge facing the world. The Intergovernmental Panel for Climate Change (IPCC) of the United Nations Environment Programme in its *IPCC Fourth Assessment Report: Climate Change 2007*(IPCC,2007) projected that heavy rains would increase in most regions of the world. And the incidence of strong typhoons along with heavy winds and intensified rains could increase in the Northwest Pacific Ocean. On the contrary, the number of drought days could increase in Southeast Asia. This forecast implies that Taiwan, as it situates in these two weather extremes, will confront with many challenges in the future. Growing evidence indicates that climate change deliver many of its impacts through floods, droughts, or extreme rainfall events, challenging daily operations and long-term planning. The effect of the climate change manifested from difficulties in operations to disrupted services and increased cost of the water services.

Taiwan Water Corporation (TWC), a state-owned enterprise that provides 8.5millions m3 of potable water in bulk everyday to 6.28 million customers (17.4million citizens) within its operational area in Taiwan, exclude Taipei City, has taken adapting strategies to incorporate climate change into infrastructure design, capital investment projects, service provision planning, and O&M to reduce their vulnerability and increase their resilience to climate change on water supply.

TAIWAN's GEOGRAPHY and CLIMATE

Taiwan is located in the Western Pacific between Japan and the Philippines off the southeast coast of China(as figure 1 shows). With a total area of about 36,179 km^2, Taiwan is 394 km long and 144 km wide at its widest point. High mountains over 1,000 meters consitute about 31 percent of the island's land area; hills and terraces between 100 and 1,000 meters above sea level make up 38 percent; and alluvial plain below 100 meters in elevation, where most communities, farming activities, and industries are concentrated, account for the remaining 31 percent.

Taiwan's most geographic feature is its 270-kilmoeter central mountain range, which has more than 200 peaks over 3,000 meters high. At 3,952 meters, Mount Jade is the highest peak in East Asia. Foothills from the central mountain range lead to tablelands and coast plains in the west and south. The eastern shoreline is relatively steep, and mountains over 1,000 meters high dominate the island in the north. There are 129 rivers in Taiwan, all of them are short with small drainage basins and are steep with rapid flows. Down stream reaches of most rivers are heavily deposited due to poor geologic conditions in the watersheds and concentrated rainfall, they are very easy to cause flooding.

Crossed by the Tropic of Cancer, Taiwan has a subtropical climate with the exception of it's extreme southern tip, which is tropical. With an average annual precipitation of 2,500 mm, it reaches 3,000 to 5,000 mm in the mountainous regions, rainfall is abundant. However, the distribution of water resources is uneven, making the water available for use per capita low. Thundershowers and the occasional typhoon bring heavy downpours in the summertime, whereas November through February is Taiwan's driest period.

ADVERSE IMPACTS FROM CLIMATE CHANGE

The history of water in Taiwan is one of conflict and perseverance. Concerns over the availability, quality and distribution of water are not new, but those concerns are growing. Solutions are becoming more complex as water managers navigate competing interests to reliably provide quality water to farms, businesses, and homes, while managing floods, protecting the environment, and complying with legal and regulatory requirements.

According to report from Taiwan Central Weather Bureau(TCWB) on Statistics of Climate Changes, Taiwan has experienced a warming effect that is twice the global average, which has translated to higher temperatures, greater rainfall, and more typhoons over the past 30 years. The report shows that while global temperatures have risen 0.65 degrees Celsius over the past century, Taiwan has seen its temperature go up by 1.4 degrees, as figure 2 shows (Taiwan Central Weather Bureau, 2009). Over the same period, the number of typhoons that hit Taiwan have also increased from 3.1 to 3.7 per year, and now these storms have a higher probability of forming in autumn than before.

Fig. 1 The location of Taiwan

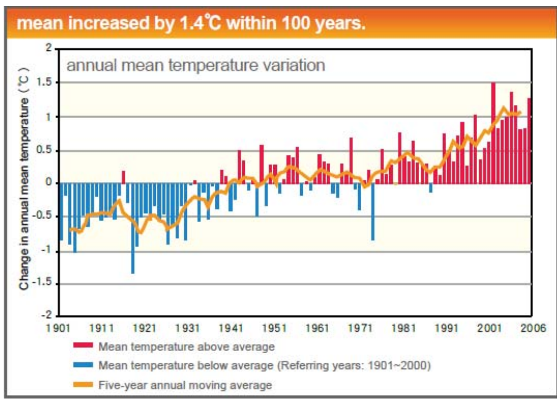

Fig. 2 Annual mean temperature in Taiwan during1900-2006.

Another report released by TCWB cited the decreased number of rainy days and the increased number of heavy-rain days as the cause for the need. The number of rainy days has declined by an average of 4.1 days every 10 years in the last century; 5.2 days per decade in the last 50 years; and 6.26 days per decade in the past 30 years. However, despite the significant declines, large changes in the annual volume of rain were not observed from the statistics as there were also more heavy-rain days during typhoon seasons as fig.3 shows(Chen, S.T., Kuo,C.C. & Yu,P.S., 2009). In fact, statistics show that the number of days with extreme rainfalls of over 200 mm has risen since 1980. In addition to more droughts and floods, statistics also found faster temperature increases in Taiwan. Temperature growth, on average, have accelerated from 0.14 degrees Celsius every 10 years in the last century to 0.29 degrees every decade in the past 30 years. The number of extremely hot days also increased. According to the report, that number on average increased by 1.36 days per decade in the past century; 2.06 days per decade in the last 50 years; and 3.96 days per decade in the past 30 years. The effects of global warming can be easily seen in Taiwan.

The trends of the last century–especially the increases in hydrological variability–will likely intensify this century, and abrupt changes in climate could also occur. The Intergovernmental Panel on Climate Change (IPCC) notes that Taiwan may be especially vulnerable to water shortages. While the existing system has some capacity to cope with climate variability, extreme weather events resulting in increased droughts and floods will strain that capacity to meet future needs. Taiwan has invested in, and now depends upon, a system that relied on historical hydrology as a guide to the future for water supply. However, due to climate change, the hydrology of the past is no longer a reliable guide to the future.

Floods

Typhoon and extreme precipitation cause flooding. The amount of precipitation is critical for water supply and environmental needs, but so is the timing of precipitation runoff into rivers and streams. Most of the precipitation in Taiwan concentrates in the Typhoon season (June, July and August). There were 426 typhoons and more than one thousand storms occurred in 1897-2010, those were most severe natural disasters in Taiwan. For those typhoons resulting in severe disasters, the intensity of precipitation is the primary cause of disaster. Figure 4 is the statistic of top 30 typhoons with extreme precipitation, which are identified based on the precipitation of the 198 typhoons striking Taiwan in 1970-2009, there is an increasing trend in the frequency of typhoon with extreme precipitation caused by climate change(Taiwan EPA, 2009). The maximum one hour precipitation reaches 300 mm and the maximum one day precipitation reaches 1,748 mm which is 93.4% of the world record (1 ,870mm). In average, there are 3.7 typhoons touched down every year and caused up to US$ 520Million nationwide, equals approximately 0.33 percent of GDP.

High frequency flood events in particular will likely increase with a changing climate. Along with extreme precipitation, scientists project greater storm intensity, resulting in more direct runoff and flooding. As streamflows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sediment loads behind dams, decreasing the capacity of reservoir storage and increasing water quality impacts of extremely high turbidity.

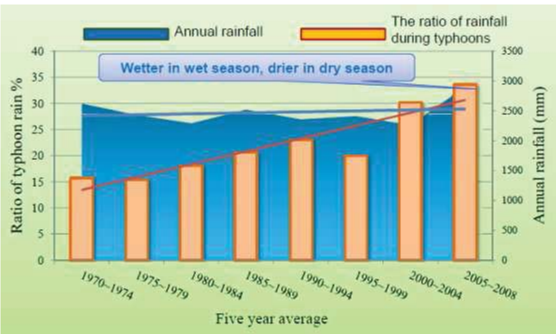

Fig. 3 The Changing Seasonal Distribution of Rainfall over Taiwan in 1970-2009

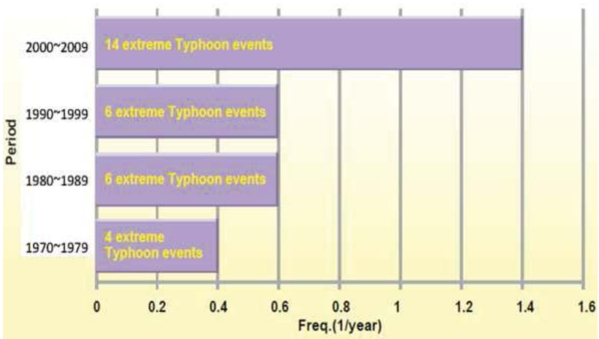

Fig. 4 Frequency of extreme typhoon rainfall over Taiwan in 1970-2009

Drought

Warming temperatures, combined with changes in rainfall and runoff patterns will exacerbate the frequency and intensity of droughts. Regions that rely heavily upon surface water (rivers, streams, and lakes) could be particularly affected as runoff becomes more variable, and more demand is placed on groundwater. Combined with urbanization expanding into wildlands, climate change will further stress the country's forests, making them more vulnerable to pests, disease and changes in species composition. Along with drier soils, forests will experience more frequent and intense dead trees, resulting in subsequent changes in vegetation, and eventually a reduction in the water supply and storage capacity benefits of a healthy forest. Climate change will also affect water demand. Warmer temperatures will likely increase evapotranspiration rates and extend growing seasons, thereby increasing the amount of water that is needed for the irrigation of many crops, urban landscaping and environmental water needs. Reduced soil moisture and surface flows will disproportionately affect the environment and other water users that rely only on annual rainfall such as non-irrigated agriculture, livestock grazing on non-irrigated rangeland and recreation.

Water quality

Changes in the timing of river flows and warming atmospheric temperatures may affect water quality and water uses in many different ways. At one extreme, flood peaks may cause more erosion, resulting in extreme high turbidity and concentrated pulses of pollutants. This will challenge water treatment plant operations to produce safe drinking water, also the stability of water supply. Flooding can also threaten the integrity of water works infrastructure. At the other extreme, lower streamflow may result in greater concentration of contaminants and lead to eutrophication may causes excessive algal bloom in surface water bodies(rivers, streams, lakes and reservoirs) and serious deterioration of water quantity. These changes in streamflow timing may require new approaches to discharge permitting and non-point source pollution control. Higher water temperatures can also accelerate some biological and chemical processes, increasing growth of algae and microorganisms, the depletion of dissolved oxygen, and various impacts to water treatment processes.

TWC's CLIMATE CHANGE ADAPTATION STRATEGIES

Taiwan's water supply systems have provided the foundation for the country's economic vitality for more than 100 years, providing water supply, sanitation, recreation and economic development. With water resources already stressed, additional stress from climate change will only intensify the competition for clean, reliable water supplies. While doing its part to reduce greenhouse gas emissions and expand the use of clean energy sources, Taiwan's water community must concentrate on adaptation strategies to respond to the anticipated changes. As understanding of climate change improves, the challenge for Taiwan Water Corporation is to develop and implement strategies that improve resiliency, reduce risk, and increase sustainability for water management systems and the ecosystems upon which they depend.

Mitigation Strategies

The mitigation strategies to climate change, or the reduction of greenhouse gas emissions that contribute to our changing climate, has received more international attention to date than adaptation. On a global scale, greenhouse gas emissions must be reduced to slow the effects of warming and climate change. In an attempt to ensure sustainability of water resource in Taiwan, the key elements of TWC mitigation strategies include following:

1. **Advocating rational reallocation of water among users, especially with regard on revision of quotas for agriculture:** Annual agricultural output in Taiwan is about US$11.8 billion, or 1.5% of GDP, but annual quotas for agriculture is about 12.6 billion m^3, or 71.07% of total water consumption. It is needed to allocate existing water resources effectively on the basis of social aspects and public-supply water demand.

2. **Suggesting to set higher water rates during periods of drought to force conservation:** Water conservation-oriented rates are an increasingly vital tool for promoting water conservation and mitigating urban drought. It has been proved that drought demand rates can produce with minimal

regulation the quadruple objectives: improving efficiency; providing revenue neutrality; assuring distributional equity and guaranteeing the conservation of water. Conservation rates has been considered as the best 'new' source of urban water during drought.

3.Advocating water conservation: As the drought crisis has become a significant issue in Taiwan, TWC needs to strengthen efforts to promote water conservation among customers, encourage people to use water-saving equipment (e.g., low flush, taps, tap plugs, water-saving basin/toilets, and washing machines.), and carry out frequent inspections on water-related equipment so that the amount of leakage will be reduced. Water-saving plugs were distributed to customers for free in the water restriction cities, which is more likely to face water shortage, in order to help water users conserve water and maintain the stability of the water supply during water shortage periods

4.Strengthen measures to fix the leaking pipelines: The total length of TWC's pipeline network is about 57,210 km was suffering from severe leakage. As climate variability caused droughts in recent years triggered TWC to take serious look at the leakage, which was as high as 24.6% in 2003. In order to control water leakage, TWC has developed five measures: organize leakage control teams, develop basic GIS pipeline network information, divides service area into thousands of DMAs to identifies water leak and then implement measures(e.g., leakage detection & repairing, pipeline renovation) to improve leakage. Through various active leakage control measures, including pressure management, efficiency and quality enhancement of leak repair work, the leakage rate has reduced from 24.6% in 2003 to 20.51% in 2010. TWC is planning to lower the leakage rate to 16% by 2016, through its 54 Billion NTD pipeline renovation project. It is estimated that around one-third of the pipelines(17707 km) in the country, need renovation, as well as reduce carbon dioxide emissions by about 27,060 t CO_2 annually.

5.Eenergy saving and carbon reduction measures: Central government issued *Sustainable Energy Policy Convention* in Jun 2008 which stated in 2025, the expected effect of CO_2 emissions can be back in 2000's level. TWC follows the policy to implement several measures to reduce CO_2 emissions: (1) Construction Terms: full life cycle, apply recycled materials, reduce fossil materials, promote low-carbon materials, introduce green materials; (2) Water treatment terms: operate by gravity, introduce green energy(e.g., solar power and LED lightening application); (3) Office terms: avoid business suit/tie, no air conditioner if temp.lower than 28℃, Off lights in lunch time, introduce auto light control to save energy.

Adaptation Strategies

The climate change adaptation strategies for TWC fall under four major categories: Preparedness, Investment, Response, and Improving Management and Decision-Making Capacity.(Taiwan Water Corporation, 2011)

1.Preparedness: In order to strengthen the existing disaster response system to ensure the water supply stability of the consumers. It is needed to formulate TWC's Emergency Response Management System to assist in adapting to climate change. The system includes following: (1)Emergency Response Plan, (2) Emergency Management Team, (3) Standard Operating Procedure(SOP) for Emergency Management, (4) Practice Codes or Operating Guidelines on Crisis and Emergency Management, (5) Disaster Prevention & Response Operating Information System, (6) Water Use Restrictions During Drought and Water Shortage, (7) Annual Emergency Response Exercise and Training.

2.Investment: Adaptive responses to climate change will not come without a cost. Climate change magnifies the problems that exist with an aging water infrastructure and presents an ongoing risk that requires a long-term financing for safe and reliable water supply to consumers. Activities include: (1)Regional water planning, inspection, maintenance, repair, and rehabilitation of water supply systems and complete the redundant water planning for every water district in order to increase the regional water supply capacity of the security and redundancy to ensure the emergency water supply during typhoons and droughts seasons, (2) In response to the inadequate capacity of public water supply reservoir due to serious flood sediments, it is needed to develop sustainable reservoir sediments management methods and reservoir conservation plans, (3)To deal with the shock loading in raw water turbidity during flood seasons, the treatment plants that are vulnerable to treat high turbidity water needed to build additional pre-settling tanks or emergency intakes on top of reservoir to intake low turbidity water , (4) Develop alternative source for low turbidity waters or backup groundwater.

3.Response: (1) After Taiwan authorities issued sea warning as typhoon approaches or an alert of an impending drought in the coming few months, TWC will set up teams to prepare for emergencies and standby to manage any possible disaster,(2) During flood seasons, TWC adopted the combined treatment process, that is, the raw water was first coagulated and settled in a pre-sedimentation tank, afterwards, its effluent was coagulated again and clarified in the clarifiers. The resulting water that was relatively stable to the shock load in raw water turbidity,(3) Practice and promote integrated operation of multi-source water supply. The operation of water systems is taking into account the principal planning objectives that include satisfying demand, delivering water of appropriate quality, prompting the use of emergency sources and reducing operating costs Is not included.

4.Improving Management and Decision-Making Capacity: Determining the impacts of climate change on the varying regions in Taiwan requires that data about our environment be collected and analyzed in a consistent and comprehensive way. Analysis of past records, current conditions, and trends can help provide a forecast for weather, climate, supply, and flooding variables. Strategic investment is needed in data analysis and archiving, and forecast tools that can support operational and policy decisions. Activities include: (1) Long-term weather risk analysis and archiving is outsourced to Specialist firm(e.g, Weather Risk Explore Inc.) (2)water-related climate change adaptation research.

CONCLUSIONS

Climate change is already affecting Taiwan’s water resources. Bold steps must be taken to reduce greenhouse gas emissions. However, even if emissions ended today, the accumulation of existing greenhouse gases will continue to impact climate for years to come. Warmer temperatures, altered patterns of precipitation and runoff, and rising sea levels are increasingly compromising the ability to effectively manage water supplies and floods.

We have known that historic hydrologic patterns can no longer be solely relied upon to forecast the water future; precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality; significant and ongoing investments must be made in monitoring, researching, and understanding the connection between a changing climate, water resources and the environment; Extreme climatic events will become more frequent, necessitating improvements in drought preparedness and emergency response; impacts and vulnerability will vary by region, as will the resources available to respond to climate change, necessitating regional solutions to adaptation; and an array of adaptive water supply strategies, such as those outlined in this paper, must be implemented to better address the risk and uncertainty of changing climate patterns.

Adapting Taiwan’s water supply systems in response to climate change presents one of the most significant challenges of this century.

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Challenges of Taiwan's Water Supply

Kuo-Ding Jou* and Tsung-Shen Liao**

* Department of Industrial Safety and Environmental Protection, Taiwan Water Corporation, No. 2-1, Section 2, Shuang-Shih Rd., Taichung City, Chinese Taiwan
** Chinese Taiwan Water Work Association, 7F., 106, Sec. 2, Chang-An E. Rd., Zhongshan District, Taipei City 105, Chinese Taiwan

Abstract
Global warming refers to changes in rainfall patterns. Extreme rainfall and its uneven distribution of rainfall is affecting stability of water supply in Taiwan by causing drought or flood conditions. With the geological structure of an island, most rivers in Taiwan are short and steep. Thus, it is a challenging task to maintain a constant reserve in the reservoirs across the island. Besides, raw water quality in Taiwan has deteriorated significantly ever since the renowned 921 earthquake, making water treatment much more difficult. The water suppliers in Taiwan are dedicated to ensuring a reliable supply of healthy, clean drinking water now and into the future. To do this, the water utilities must continue to protect its existing water supply sources and infrastructure and implement a number of currently planned water system improvements. This paper would give an insight of the Taiwan water utilities management strategies, which would help improves the water utilization and achieving the sustainable water resource management.

Keywords
Taiwan Water Supply, Taipei Water Department, Taiwan Water Corporation

TAIWAN

Geography

Taiwan (Figure 1), is located east of the Taiwan Strait, off the southeastern coast of mainland China. Separated from the Asian continent by the 180-kilometre-wide Taiwan Strait, the main island is 394 kilometres long and 144 kilometers wide, and has an area of 35,801 km^2. The population was estimated in April 2011 at 23,061,689, making it the twelfth most densely populated country in the world with a population density of 668/km^2.

Topography

The island is long and narrow with the Central Mountain Range in the middle. The mountainous area with elevation higher than 1,000m occupies 32% of the island, and hills and plateaus of 100m to 1,000m cover 31% of the island. Taiwan's highest point is Jade Mountain at 3,952 meters.

Fig. 1 Map of Taiwan Source: the World Factbook, CIA)

Geology

Most of the mountain regions in Taiwan are sedimentary and metamorphic rocks which are fragile and highly weathered. Severe erosion occurs due to intensive rainfall and rapid flows, the erosion is even worsen by frequent earthquakes and severely affects the stability of hillsides.

Climate

Taiwan's climate is marine tropical. The northern part of the island has a rainy season that lasts from January through late March during the northeast monsoon, and experiences meiyu in May. The middle and southern parts do not have an extended monsoon season during the winter months.

Natural Hazards

Besides an average of 3 to 5 typhoons strike Taiwan annually, natural hazards such as earthquakes are common as well in the region. The major seismic faults in Taiwan correspond to the various suture zones between the various terrains. These have produced major quakes throughout the history of the island. The seismic hazard map for Taiwan by the USGS shows 9/10 of the island as the highest rating. On September 21, 1999, a 7.3 quake known as the "921 earthquake" occurred. Due to the fragile geological conditions and steep terrain of the mountain area, Taiwan is prone to the debris flow and slope hazards caused by typhoons, severe rain falls, and earthquakes, which often cause human lives and induced severe damages to properties.

WATER SUPPLY IN TAIWAN

History

Taiwan established its first public water works more than 120 years ago, while tap water systems here date back 112 years. In 1885 the provincial governor under the Qing Dynasty, Liu Ming-chuan, had Taiwan's first public water works system built in northern Taiwan, drilling wells and installing filtration and purification systems to improve the quality of drinking water. After the Japanese took over the island in 1895, the Danish engineer E. Hanson conducted a survey and identified four locations of water sources. William K. Burton, a British sanitation engineer soon thereafter spent 32 months overseeing the construction of a water supply system. Completion of this system in 1899 marked the birth of Taiwan's first tap water plant. A settlement and filtration facility was then built in Keelung in 1902, and in 1907 the Taipei Tap Water Plant was completed.

To make integrated use of resources, 128 waterworks scattered throughout Taiwan were merged on January 1st, 1974 into Taiwan Water Corporation (TWC). Then on January 1st, 1977 Taipei Water Department (TWD) was established. TWD now delivers over 2.6 million tons of water per day, while TWC delivers 8.6 million tons, for a combined daily total of more than 11.2 million tons. Water supply coverage nationally now stands at 95.1%.

Environment

Global warming refers to changes in rainfall patterns. Extreme rainfall and its uneven distribution of rainfall is affecting stability of water supply in Taiwan by causing drought or flood conditions. With the geological structure of an island, most rivers in Taiwan are short and steep. Thus, it is a challenging task to maintain a constant reserve in the reservoirs across the island. It is widely known that Taiwan is prone to earthquake. Damage below the ground surface caused by earthquakes usually is just as devastating as the structural damage above the surface. As shown in Fig. 2, a 2,600mm pipe was damaged in the 921 earthquake. Besides, raw water quality in Taiwan has deteriorated significantly ever since the 921 earthquake, making water treatment much more difficult. Water suppliers in Taiwan are dedicated to ensuring a reliable supply of healthy, clean drinking water now and into the future. To do this, the water utilities must continue protecting its water sources and infrastructure and implement currently planned water system improvements.

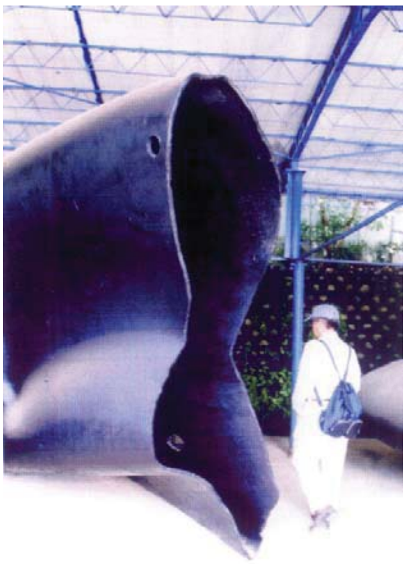

Fig. 2 Damage to a 2600 mm Pipe in the 921 Chi-Chi earthquake

Water Utilities in Taiwan

Two systems take care of the daily water supply for the entire Taiwan area; one is for the Taipei metropolitan area and the other is for the rest of Taiwan.

Taipei Water Department

As a public utility operator under the Taipei Municipal Government's jurisdiction, TWD now supplies 2.6 million tons of potable water a day to over 3.8 million users in the Taipei metropolis.

Service Area

The service area of TWD, which include Taipei City and neighboring cities and towns, covers an area of 434 square kilometers.

Characteristics

Xindian River, the only natural surface water resource of TWD, provides 97% of TWD's raw water. With only one single water resource, the Taipei metropolis is not only vulnerable to drought in low water periods with unbalanced rainfall input, but also bears the risk of water shortage in high water periods. The reason for the latter is that the watershed of Xindian River is located in a mountainous area with steep slopes, and typhoon or rainstorm events usually generate a great amount of silt, which causes the raw water turbidity to increase suddenly from less than 10 NTU to as high as 1,000s or even more than 10,000 NTU.

TWD built 5 purification facilities at the Zhitan purification plant between 1984 and 2004. With a total capacity of 2.7 million tons per day, which accounts for 71.37% of the total output capacity, the Zhitan purification plant was the largest purification plant in south-east Asia until 2008.

Taiwan Water Corporation

TWC was set up in 1974. As a public utility operator under the Ministry of Economic Affairs, TWC now supplies 9 million CMD of drinking water to over 18 million users. Raw water of Taiwan mostly comes from seasonal rainfalls over the central ridge mountain area and is recovered by pumping it from dams, reservoirs, rivers and deep wells. After treatment and storage, the fresh water is fed to the widely spread cities through long-distance aqueducts and pipelines. Currently, TWC operates and maintains more than 55,000 kilometers of water lines: main aqueducts.

Service Area

The service area of TWC covers the Penghu islands and the whole Taiwan Island except the area serviced by TWD.

Characteristic

TWC has 128 waterworks in total scattered all over Taiwan. Unlike TWD with only one water source, TWC has all kinds of water sources, such as rivers, lakes, reservoirs, ground water and desalination as well. The water quality of raw water varies from source to source. The rivers in Taiwan have the steepest slope, the largest discharge per unit drainage area, and the shortest flood peaking time in the world. Extreme rainfall and its uneven distribution is affecting stability of water supply in Taiwan by causing drought or flood conditions. In most cases, reservoirs and ponds can often dampen the impact of increased turbidity events by acting as points in a stream or river where particles can settle before being drawn into the intake of a treatment plant. However under flood conditions, turbidity of the raw water from reservoirs or ponds sometimes can soar up to 30,000 NTU and even more. Nevertheless, this high turbidity raw water is to be treated for water supply. With all these unfavourable natural conditions, stability of water supply measures becomes the foundation of steady growth of this country.

WATER SUPPLY OPERATION AND MANAGEMENT

TWD

Water Shortage

The Xindian River watershed had long been well protected, and the raw water has always maintained a high standard of quality. However, due to occasional water supply shortages in summer months, the Xindian River could no longer be regarded as a reliable water resource for the Taipei metropolis. For example, a drought occurred in 1980 that forced Taipei City to carry out a rotational water supply measure for one month. Thus, to solve the problem once and for all Taipei City Government built the Feitsui reservoir in 1987, which has a storage capacity of over 400 million cubic meters. The sole purpose of this reservoir is to provide drinking water. When most of us considered weather conditions no longer a problem to the daily water supply for Taipei, in 2002, the most serious drought in 22 years occurred in northern Taiwan and lasted for four months.

Non-Revenue Water (NRW) Reduction

In retrospect, the history of water supply infrastructure construction in Taipei metropolis reveals the problem. In past 2 decades, in order to satisfy the increasing water demand of the rapid economic and urbanized development, TWD had focused on the expansion of water supply facilities. Therefore, the quality of pipeline construction was usually ignored, which resulted in high leakage rates. The situation made the effective use of water resources the focal point of Taipei City Government. It also forced TWD to plan long-term action solutions: overall promotion of network replacement; strengthening the reserve capacity and backup system; and the promotion of a sustainable water supply. Among these three challenges, the most difficult one is reduction of NRW tackled through a long-term network improvement plan, which aims at boosting the utilization rate of water resources. Starting 2003, 1% NRW reduction per year is expected.

Pipeline Network Improvement

Affected by climate variation, the rainfall has become very unstable. In addition, the rising awareness of Environmental protection has made development of new water resources even more difficult, thus the reduction of NRW has become the measure that TWD should be executing. In Tokyo, Japan for example, over 20 years, 3800 zoned pipeline networks were established to facilitate the implementation of leaking prevention measures, and it has achieved outstanding results. Thus, TWD recognized that the leakage prevention plan is a long-term task and its goal cannot and should not be reached in one step. As a result, TWD took the time to study the successful experience of long-term leakage prevention by the Bureau of Waterworks of Tokyo

Metropolitan Government and design a 20-year long-term pipeline network improvement plan which conforms to the demands and characteristics of Taipei metropolis.

In 2003, TWD decided to adopt the District Metered Area (DMA) method, a zoning and metering approach which is widely used by many public utilities to facilitate the implementation of leakage prevention measures, then divided its service area into 850-900 DMAs after finding that most DMAs which had been tried showed satisfactory results. In particular, TWD carried out the evaluation of the leaking situation of those DMAs it chose by metering the water sold in each DMA, then replacing any aged and leaking mains with DIP throughout the weak areas of the network in each DMA, and replacing service pipes with SSP. TWD also adopted various active leakage control measures, including pressure management, efficiency and quality enhancement of leak repair work, all aiming to increase the benefits of leakage improvement.

From 2003 to 2025, US$ 800 million will be invested in improvement of pipeline network for reducing leakage rate by 1% per year. From 2003 to 2008, TWD established more than 400 DMAs. In terms of the implementation of the long-term network improvement plan, the annual pipeline replacement rate has increased from 1.6% to 2.6%, which is well above the standard of 1.5% suggested by the International Water Association (IWA). Since 2008, TWD's distributed water quantity has been reduced by 200,000 CMD, and the leakage rate has also been reduced from 28.43% in 2003 to 23.61% in 2008, and is expected to reach 10% by 2025.

TWC

Advanced Water Treatment

Faced with a small land area and an enormous human population, most usable land in Taiwan is subject to intensive development. Many water source areas are therefore exposed to household, agricultural and industrial waste, which is most obvious in southern Taiwan. Kaohsiung, the second largest city of the country and the largest city in southern Taiwan, once had as many as 600,000 pigs raised within its water source areas. Effluent from pig farms seriously polluted these water sources and forced water purification plants to use large quantities of chlorinated decontamination agents. The populace has since lost confidence in tap water and began purchasing bottled water. Therefore, in recent years Taiwan EPA has integrated related competent authorities to carry out a series of measures to reduce pollution of water sources and improve drinking water quality.

As drinking water standards become more stringent, existing water treatment facilities are not able to keep up with the new standards. TWC must allocate a massive budget to enhance and upgrade its water treatment abilities so as to fulfil relevant regulations.

Three advanced water treatment plant projects have been in progress, including Fengshan Rehabilitate-Operate-Transfer (ROT) project, with ozonation and activated carbon; Tanting Build-Operate-Transfer (BOT) project, with membrane filtration; and Chengching Lake BOT project, with crystallization softening and ozone-activated carbon treatment.

Desalination

Due to lack of water resources, desalination has become the solution to water supply stability in Penghu islands, where the population is 93,300. There are four desalination plant BTO (Build-Transfer-Operation) projects in progress, among which Magong-1 (5,500 ton/day) and Siyu (750 ton/day) desalination plants have been completed in 2009. Total investment of these two projects is NT650 million (USD19.7 million) and NT165 million (USD5 million) respectively. Magong-2 (4,000 ton/day) and Gibay (500 ton/ day) desalination plants are in the stage of feasibility study and will be fully completed in 2012 and 2014 respectively.

Over-Age Pipe Replacement

When TWC was established in 1974, Taiwan's tap water penetration rate was only 42%, far behind developed countries. At the time, low-priced pipes were used in order to rapidly boost the tap water penetration rate on a limited budget.

Currently, PVC is the most widely used water pipe material, accounting for 65% of existing pipes. Tap water pipes have been severely damaged since economy grade pipes have lower durability and suffer chronic effects from other adverse factors such as natural disasters and vehicle pressure. Also, water rates have been frozen for a long time, resulting in financial difficulty for TWC. Since a pipe replacement budget had been lacking for years, the ratio of pipes that are over-age has reached 30%. Furthermore, TWC's average annual pipe replacement rate has been only 0.88% over the past 15 years, much lower than the recommended standard of not less than 1.5% advised by the International Water Association (IWA). To improve the poor performance distribution network, TWC expects to spend 1.6 billion USD in the next 6 years.

Water Rate

The water rate in Taiwan has not been changed since 1994. Whether the rate should rise to reflect true cost of water supply needs a rational discussion. According to the latest "International Statistics for Water Service" released by the International Water Association (IWA) in September, 2010, among 29 countries in the world, the average water price of Taiwan Water Corporation, which is 0.33 USD, ranks No. 27, only 22.6 percent of the 29 countries' average price, which is 1.46 USD. During the period of 1998 to 2007, the GDP increased from 12,679 USD to 16,792 USD, and family expenditure rose from 646 thousand NT up to 716 thousand NT on the average in Taiwan, whereas the water expenditure of the total family expenditure was estimated to decrease to 0.30 percent from 0.34 percent, which is much less than the guideline recommended by the WHO.

OUTLOOK

Enhancing Reserve and Back-up Capacity

With only one single water resource, the Taipei metropolis is not only vulnerable to drought in low water periods with uneven rainfall input, but also bears the risk of water shortage in high water periods. Compared with advanced countries like Europe, USA and Japan that frequently build at least 50% reserve capacity for their purification plants; Taiwan's purification plants have only a 15% reserve capacity in total, and commonly with only one raw water transmission mains in service. This means the utilities are not well-equipped to deal with an unexpected typhoon or rainstorm. Therefore, the measures, including building underground distribution reservoirs and Regional water supply backup systems, to enhance reserve and back-up capacity can not be over-emphasized.

Green Water Supply

The water utilities in Taiwan are trying to promote green water supply, in the following ways:

***Green production**:* Since 2006 TWD has made efforts in every aspect, including treatment process, distribution, lighting, air conditioning, etc., to reduce energy consumption in water supply. The CO_2 emission per ton of water production has been successfully decreased from 0.107 kg in 2007 to 0.097 kg in 2009.

***Green service**:* There is not only 24/7 call centre services available, but customers can also pay their water bills and fill out many other application forms concerning water supply on website. There are also various channels available through which customers can pay their bills, such as banks, convenience stores, ATMs and cell phones. All application or request by customers can be made through telephone and internet, with which e-bill is promoted with NT$3 rebate for each bill. Non-counter service payment ratio has reached 97.02% and payment through convenient store has reached 44.3%.

***Green responsibility**:* the utilities help to develop an awareness of environmental protection in every corner of our society, in the hope that water saving becomes a good habit of everyone. Both TWD and TWC have promoted a household water conservation program, in which million households have received or will receive a water conservation kit for free. Besides, to promote green energy, since 2003 TWD has been installing solar power panels over the sedimentation tanks in one of the treatment plants.

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The emergency treatment study of excessive DOC from bottom layer reservoirs water

Tin-Lai Lee[1], Sheng-I Tseng[1], Winn-Jung Huang[2], Chia-Hung Liu[3], Hsuan-Hsien Yeh[3]
1. Department of Water Supply, Taiwan Water Corporation, No. 2-1, Sec.2, Shuang Shih Rd., Taichung City, 40425, Taiwan
2. Department of Safety, Health and Environmental Engineering, Hung Kuang University, Taichung 43302, Taiwan
3. Department of Environmental Engineering, National Cheng Kung University, Tainan 70101, Taiwan
(E-mail:tinlai@mail.water.gov.tw)

Introduction

The source water of Taiwan's public water supply mainly comes from reservoirs. However, many reservoirs face low water level problem, caused by increased water demand and also maybe drought incurred by climate change. Water treatment plants may encounter excessive dissolved organic in the source water when they are forced to pump bottom layer water from the reservoirs during dry season. In this study, both lab and pilot scale experiments were conducted to evaluate various methods to enhance organic removal. Those included optimization of preoxidation and coagulation, dosing powdered activated carbon (PAC), and using granular activated carbon (GAC)

Experimental Methods

Lab-scale test

In the lab-scale tests, powdered activated carbon adsorption, pre-oxidation with either NaOCl and/or $KMnO_4$, and coagulation with either alum or $FeCl_3$, using jar test apparatus, were conducted with reservoir waters, in order to see their effectiveness on the removal of dissolved organic.

Pilot-scale test

The pilot plant testing was used to verify the results from lab-scale study. The treatment process included preoxidation, rapid mixing, slow mixing, sedimentation, filtration, and disinfection. Figure 1 is the schematic flow diagram of the pilot plant. Table 1 lists the operational parameters of the major units. The source water, the effluent from sedimentation tank, and filtrates from both filters were collected for water quality analysis.

Table 1 Operational parameters of major pilot plant units

Unit	Operational parameter
PAC contact column	Detention time : 20 min
Rapid mixing basin	Detention time: 90 s G value: 750 sec^{-1}
Slow mixing basin	Detention time: 25 min G value: 29 sec^{-1}
Sedimentation basin with inclined tube	Detention time : 108 min Overflow rate: 22.5 m/day
Silica sand filter	E.S. 0.9 mm, U.C. 1.5, depth 1 m Filtration rate: 180 m/d
GAC filter	E.S. 1.0 mm, U.C. 1.5, depth 1 m Iodine Number 900 mg/g

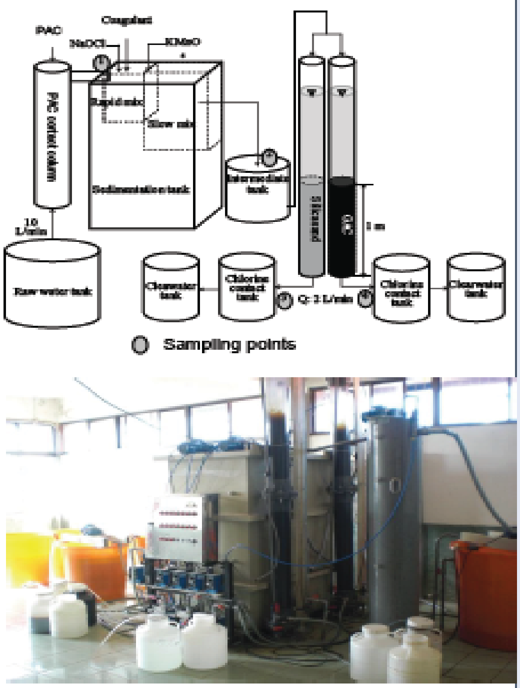

Fig. 1 Schematic flow diagram of the pilot plant

Results and Discussions

Dissolved organic removal by jar test

Figure 2 shows that high preoxidants dosage, no matter it was chlorine or permanganate, would resulted in higher residual NPDOC in the supernatants. This was probably caused by the oxidation of suspended organic colloids into soluble ones. It also found that the dissolved organics, produced by high dosages of permanganate during preoxidation, could be removed in the subsequent iron salt coagulation. However, those dissolved organics could not be removed by alum.

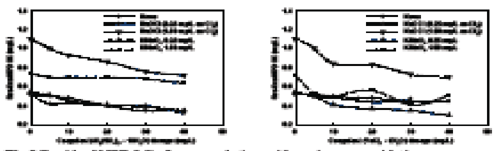

Fig.2 Residual NPDOC after coagulation with various preoxidation conditions

Dissolved organic removal by pilot testing

The results from pilot plant testing also confirmed that permanganate preoxidation followed by ferric chloride coagulation have higher NPDOC, THMFP, and HAAFP removal than preoxidation coupled with alum coagulation (Table 2)

Table 2 Comparison of organic content of the effluent from sand filter under different preoxidation condition and coagulants

Item	Alum			Ferric chloride		
	None	Pre Cl_2	Pre $KMnO_4$	None	Pre Cl_2	Pre $KMnO_4$
NPDOC (mg/L)	1.35 (15 %)*	1.34 (14 %)	1.30 (17 %)	1.25 (17 %)	1.16 (24 %)	1.17 (25 %)
THMFP (μg/L)	42 (44 %)	44 (35 %)	57 (30 %)	39 (35 %)	37 (47 %)	40 (48 %)
HAAFP (μg/L)	39 (39 %)	37 (37 %)	45 (34 %)	40 (32 %)	39 (39 %)	41 (39 %)

* Percentage of removal

Factors affecting the function of organic removal by PAC

Although PAC was found to be effective for enhancing dissolved organic removal, some factors may affect its performance. Table 3 compares organic removal by adding PAC (30 mg/L) in the contact basin before rapid mixing with and without adding sodium hypochloride solution into the rapid mixing basin. The results show that organic removal was significantly reduced by prechlorination.

Next, we look into the effect of dosing site of PAC on its organic removal efficiency. Table 4 compares the results from adding PAC before the rapid mixing basin with those from adding PAC in the contact basin after setting tank. The latter shows better organic removal. One of possible explanation is when PAC was added before coagulation; it may be served as the nuclear and covered by the hydrolyzed products of coagulant. Therefore, inhibit it adsorption efficiency.

Table 3 Effect of prechlorination on organic removal by PAC

Items	Prechlorination (none)			Prechlorination (0.23 mg/L as Cl_2)		
	Raw water	Settling tank effluent	Sand bed effluent	Raw water	Settling tank effluent	Sand bed effluent
NPDOC (mg/L)	1.38	0.68 (50.7 %)	0.64 (53.6 %)	1.05	1.03 (1.9 %)	1 (4.8 %)
THMFP (μg/L)	106.1	42.4 (60.1 %)	57.7 (45.6 %)	97.4	49.3 (49.4 %)	78 (19.9 %)
HAAFP (μg/L)	71.6	44.6 (37.8 %)	34 (52.5 %)	64.2	37.7 (41.3 %)	46.8 (27.1 %)

Table 4 Effect of PAC dosing site (dosage 30 mg/L) on organic removal

Items	Contact basin before rapid mixing			Contact basin after settling tank		
	Raw water	Settling tank effluent	Sand bed effluent	Raw water	Settling tank effluent	Sand bed effluent
NPDOC (mg/L)	1.05	1.03 (1.9 %)	1 (4.8 %)	1.05	1.06 (-1 %)	0.74 (29.5 %)
THMFP7day (μg/L)	97.4	49.3 (49.4 %)	78 (19.9 %)	61.6	45 (26.9 %)	34.3 (44.3 %)
HAAFP7day (μg/L)	64.2	37.7 (41.3 %)	46.8 (27.1 %)	70.9	41.6 (41.3 %)	35.1 (50.4 %)

Conclusions

(1)Both lab- and pilot- scale testing showed that powdered activated carbon could enhance the removal of dissolved organic compounds.

(2)Organic removal by coagulation and powdered activated carbon was impeded by prechlorination.

(3)The pilot testing showed that if powdered activated carbon was added into a contact basin after sedimentation tank, it would have higher dissolved organic removal than when powdered activated carbon was added before rapid mixing tank.

Acknowledgement

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附錄8

Applicability study of full -scale filter filtration and backwash performance assessment methods

Tin-Lai Lee[1], Wen-Hsiang Chen[1], Chih-Chao Wu[2], Chi-Chuan Kan[3]

1. Department of Water Supply, Taiwan Water Corporation, No. 2-1, Sec.2, Shuang Shih Rd., Taichung City, 40425, Taiwan
2. Department of Environmental Engineering and Science, Feng Chia University,100 Wenhwa Rd., Seatwen, Taichung 40724, Taiwan
3. Department of Environmental Engineering and Science, Chia Nan University of Pharmacy and Science, Tainan 71710, Taiwan, ROC.

Abstract

Filtration is the last step of conventional treatment process before water is distributed to the consumers. The performance of the step directly affects the quality and quantity of distributed water. The objective of this study is to evaluated the applicability of filter filtration and backwash performance assessment methods according to the Filter Assessment Manual for fifteen WTPs with capacity over 50,000CMD in Taiwan.

The filter performance methods includes visual assessment, filter media thickness, gravel height measurement, and media property analysis. The on-site evaluation results suggest that the Aquazur type and the Wheeler type filters scores highest, followed by Green-Leaf filters. The ABW filters are the poorest.

The team also evaluated the backwash performance according to the Filter Assessment Manual. The evaluation includes analysis of filter backwash operation, filter bed backwash expansion rate test, and filter floc retention test before and after backwash. The result again shows that Aquazur scores highest, followed by Green-Leaf filters. The ABW filters are the poorest.

Introduction

The objective of this study is to investigate and analyze the current status and problems of rapid filter of water treatment plants(WTPs) in Taiwan. The results show that the Aquazur type, Green-Leaf type, ABW filter, and Wheeler type are common filter types in Taiwan.

Methods and Materials

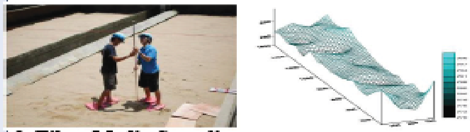
A full-scale filter assessment may involve most or all of the test procedures outlined in FILTER ASSESSMENT MANUAL (South Carolina Department of Health and Environmental Control, South Carolina, 2003). In summary, a complete filter assessment is a comprehensive search for anything that is hindering the performance of a non-optimized filter.

Assessment items:

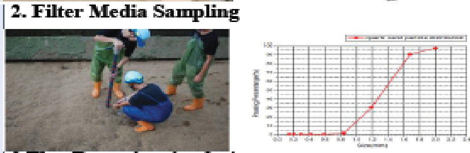
1.Instrumentation Check & Data Reliability
2.Gathering Historical Filter Information Regarding Performance & Design
3.Gravel Mapping & Measuring Media Depths
4.Visual Inspection of Media Condition
5.Procedures for Chemically Cleaning Media
6.Filter Media Sampling
7.Floc Retention Analysis
8.Visual Backwash Observation
9.Bed Expansion Test
10.Backwash Water Turbidity Profile
11.Rewash Water Turbidity Profile
12.Assessing Rate-Of-Flow Controllers & Filter Valve Infrastructure
13.Evaluating Filter Run Profiles

Results and Discussion

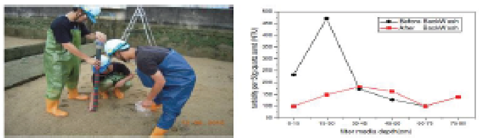
1. Gravel Mapping & Measuring Media Depths



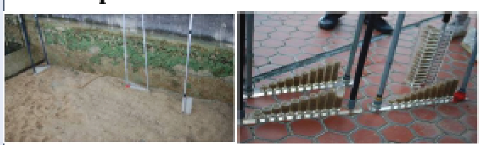
2. Filter Media Sampling



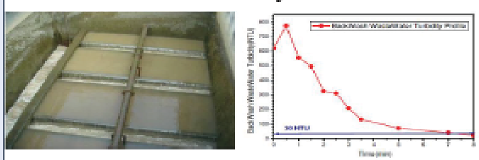
3.Floc Retention Analysis



4. Bed Expansion Test



5. Backwash Water Turbidity Profile



Conclusion

The study conclude that Aquazur, Wheeler, Green-Leaf filters can pass the evaluation performed by the study team, provided that the strict operation procedures are followed. Therefore, the standardized testing procedures needed to be developed to enhance the evaluation methods.

附錄9

Case Study of Booster Chlorination in Water Distribution Network in Kaohsiung City

Tsai-Hsing Hsiao
Water Quality Inspection Office, Seventh Branch , Taiwan Water Corporation , No.32 Dapi Rd., Niasong District, Kaohsiung City, Chinese Taiwan.
(E-mail:hary@mail.water.gov.tw)

INTRODUCTION

There are five water treatment plants (WTPs) and complicated distribution systems are existed in Kaohsiung city , Taiwan. In the dead-end of a distribution networks, water quality can deteriorate through mechanisms like intrusion, regrowth of bacteria in pipes and storage tanks, water treatment failure, leaching of chemicals or corrosion products from system components and permeation of organic compounds through the pipe wall. Microorganisms tends to be a problem in distribution systems where a residual concentration of chlorine has not been maintained. Ranging from January to October in 2003,118 abnormal cases of water quality of users was reported to complain too heavy odor of disinfection (about 25 %) and in which the users in front pipe area of distribution systems are most.

The Booster chlorination station (BCS) was setting up according to fifty monitoring sites of water quality in distribution system which was located in pipeline terminal regions or in higher height regions in Kaohsiung city. In this work we selected six BCSs to study variation of water quality in setting up before and after. The concentration of free residual chlorine in treated effluents was controlled about 0.6 mg/L at five WTPs.

Results show that the settlement of BCSs is indeed (1)to improve effectively the short of free residual chlorine supplies in pipeline terminal region in distribution system ,(2) to decrease the concentration of THMs,(3) to elevate qualified percentage of water quality and (4)to ensure safety drinking water in consumers.

RESULTS AND DISCUSSIONS

1. Monitoring stations at pipeline-ends

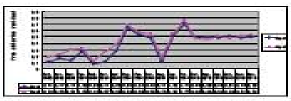
The selections for pipeline-end monitoring stations were based on inspection results conducted by the environmental protection agency over many years and the company's pipeline distribution map in the Kaohsiung area. Eleven stations were selected as shown in Table 1.

Table 1. Pipeline-end monitoring stations in the Kaohsiung area.

Serial number	Sampling location	Serial number	Sampling location
Nan1	No. 24-7, Dejheng Rd.	CI2	No. 342-1, Zhongzho 2nd Rd.
Nan2	No. 493, Dejheng Rd.	CI3	No. 6, Alley[illegible], Lane [illegible]
Cian4	Kaohsiung weather station	YanZianXin 4	No. 67, Sinle St.
Cian8	No. 374, Cianjhen Rd.	YanZianXin 5	No. 118, Guangfu 3rd St.
Lling2	No. 87, Wingtak St.	YanZianXin 7	No. 186, Daren Rd.
CI1	No. 16, Yong'an Rd.		

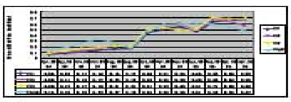
2. Analysis of changes in water quality before and after the establishment of midway chlorination stations

(1) Xingzhong Bridge Nanzih District



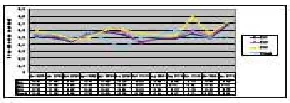
The sampling values for Nan1 and Nan2 in August 2004 were 0.11 and 0.18 mg/L respectively, but were proven to be caused by the malfunctioning of chlorination devices.

(2) Cross Harbor Tunnel



Midway chlorination stations were established at 500 m/m and 150 m/m along the pipeline in front of the Cross Harbor Tunnel in the beginning of October 2004

Ever since the Fengshan Advanced Water Purification Plant was completed, opened to traffic, and passed its trail runs at the end of December 2007, chlorine residual contents reached 0.30 mg/L or above before reaching all midway chlorination stations.



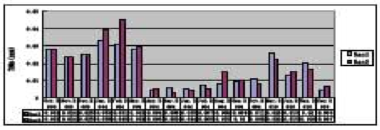
3. Analysis of consumer complaints in regards to disinfectant smell

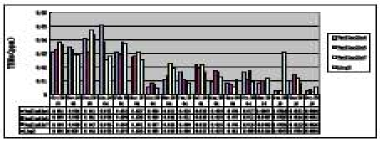
(a) Before the establishment (b) After the establishment

Among all, complaints about the smell of disinfectant comprised roughly 25% of all complaints.
Free residual chlorine in water treatment plants had dropped from a maximum of 1.0 mg/L, to 0.6 mg/L.

Consumers at the front-end and midway of the pipelines felt that the disinfectant smell was less apparent, and complaints on this matter dropped significantly, finally comprising about 7 % of all complaints.

4. Analysis of Chlorination by-products





According to the literature, chlorination quantity is one of the factors that induce the genesis of chlorination by-products, and many of the by-products generated during chlorination disinfection have been proven to be carcinogenic and mutagenic. Of these by-products, trihalomethanes were the first to receive attention.

Therefore, controlling the amount of chlorine added became an important factor for controlling the genesis of chlorination disinfection by-products. Because of the midway chlorination stations, the amount of residual chlorine in the water outlet of the treatment plant was lowered, and the amount of chlorine added was lowered accordingly; therefore, the amount of trihalomethane produced should theoretically be under control.

Water quality before and after the establishment of midway chlorination stations at Xingzhong Bridge and Zhongshan 3 rd Rd. Bridge were analyzed for trihalomethane content. It was shown that the amount of trihalomethane was indeed lowered during

CONCLUSION

(1) Establishing midway chlorination stations effectively reduced the problem of insufficient chlorine content at the pipeline terminals, improved the rate of water qualification, and assured that consumers are provided with safe drinking water.

(2) Because water treatment plants reduced the amount of chlorine residual in water outlets to approximately 0.6 mg/L, complaints about "a strong disinfectant smell" made by consumers at the front-end and midway of the pipelines decreased by over 70%, further improving the drinkability of tap water. This improved the company's overall image.

(3) Due to the decrease in chlorine residual content in the water outlets of water treatment plants, the amount of chlorination disinfection by-products such as trihalomethanes decreased accordingly; further ensuring consumers of the safety of their drinking water.

(4) The disqualification rate of water quality at the tail-end of the pipelines or in higher ground areas was reduced, thereby reducing expenses for fines.

(5) The dosing rate of chlorination residuals at water outlets of water treatment plants was effectively reduced; thereby reducing the costs for chemical reagents.

(6) Exceptional conditions during midway chlorination were frequent, for instance: 1. Errors in displayed and actual values on chlorine residual were more than 10 %; 2. recording paper malfunction; 3. leakage of sodium hypochlorite; 4. dosing machine malfunction.

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