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香港環境輻射監測摘要
Summary of Environmental Radiation Monitoring in Hong Kong

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摘要

香港天文台環境輻射監測計劃在二零一二年踏入第二十六年。本年報收錄了監測計劃在二零一二年的主要工作內容、測量方法及結果。年報亦介紹了新的工作項目和轉變。

日本福島核事故發生於二零一一年三月，天文台在二零一一年三月底至四月底曾於空氣樣本中檢測出微量的人工放射性核素碘及銫，但由於放射性活度極低，對人體健康並無影響（*香港天文台，2012*）。

在二零一二年，天文台的輻射監測網絡錄得的環境輻射水平均在正常本底變化範圍之內。所有環境樣本的測量結果均與日本福島核事故前的情況相若，空氣樣本中沒有檢測出任何人工放射性核素，而個別環境及食物樣本中只測量到微量的人工放射性核素，包括銫-137、氚、鍶-90 及釷-239，分析結果與多年來的結果並沒有顯著分別。相信這些放射性核素主要來自一九四五至一九八零年間的大氣核武試驗，而福島核事故對本港的環境輻射水平並沒有造成長遠影響。

二零一二年的測量結果顯示，自廣東核電站及嶺澳核電站運作以來，香港的環境輻射水平、環境樣本及市民日常食用的食品中的人工放射性核素活度並沒有可測量到的變化。

ABSTRACT

The Environmental Radiation Monitoring Programme of the Hong Kong Observatory entered its twenty-sixth year in 2012. This annual report incorporates salient features of the work of the programme during 2012, including a brief report on measurement methods and results, highlights of relevant new work and changes.

The Fukushima nuclear accident in Japan occurred in March 2011. Minute amounts of artificial radionuclides, namely radioactive iodine and caesium, were detected in some air samples collected by the Observatory between late March and late April 2011. However, as the radioactivity of these radionuclides was very low, they posed no threat to human health (*Hong Kong Observatory 2012*).

In 2012, the ambient radiation levels in Hong Kong as measured by the Observatory's radiation monitoring network were within the normal background range. The measurement results of all environmental samples were similar to those before the Fukushima nuclear accident. No artificial radionuclide was detected in air samples, whereas only trace amounts of artificial radionuclides, including caesium-137, tritium, strontium-90 and plutonium-239, were detected in some environmental and food samples. The levels of all these radionuclides were not significantly different from those recorded in previous years. Their presences were primarily attributed to the atmospheric nuclear weapon tests between 1945 and 1980. The Fukushima nuclear accident did not bring any long-term effect to the ambient radiation levels in Hong Kong.

Based on the measurement results in 2012, it is concluded that there was no measurable change in the ambient radiation levels in Hong Kong, activities of artificial radionuclides in the Hong Kong environment and foodstuffs consumed by Hong Kong people, as compared with those before the operations of the Guangdong and Lingao nuclear power stations.

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1. 引言

香港天文台早於一九六一年開始監測香港的環境輻射水平，並參與由國際原子能機構(IAEA)和世界氣象組織(WMO)舉辦的國際性環境輻射監測計劃。由於興建廣東大亞灣核電站，天文台於一九八三年開展了一項全面的計劃，以監測核電站運作前後香港的環境輻射水平。

該計劃包括分為兩個階段的「環境輻射監測計劃」(ERMP) 。ERMP 第一個階段為期五年，稱為「本底輻射監測計劃」(BRMP)，於一九八七年至一九九一年進行，務求在一九九四年廣東核電站（位置見圖 1）投產之前，確定香港的本底輻射水平，作為基準線，以判別核電站運作後可能為香港輻射水平帶來的影響。監測結果可參考 BRMP 的報告（*香港天文台，1992*）。

ERMP 的第二階段由一九九二年開始運作至今，內容涵蓋 BRMP 內的所有重要項目，並因應所得經驗於採樣及測量工作上作出修訂。ERMP 是一項持續進行的計劃，目標是監測香港環境輻射水平的長期變化，尤其是廣東核電站與嶺澳核電站分別在一九九四年及二零零二年運作後可能出現的任何變化。

ERMP 的監測結果在計劃的年報和摘要中發表（http://www.hko.gov.hk/publica/pubrmc.htm）。讀者可參閱有關報告，以瞭解計劃的採樣、測量及質量保證工作的詳情。自二零零三年開始，監測計劃的年報實行精簡化，年報只收錄計劃的重點，包括測量方法和結果的總結，及該年工作的摘要、轉變或新措施。。

本報告的第 2 章介紹監測計劃的取樣工作、環境輻射水平、食物和環境樣本放射性的測量方法及儀器，以及質量保證。第 3 章則臚列二零一二年的測量結果及所得的結論。

2. 取樣、測量及質量保證

ERMP 的焦點集中在大氣、地面和水體三個主要照射途徑。測量工作主要包括兩個部份。第一部份是直接測量香港的環境輻射水平，第二部份是測量香港的環境樣本及市民日常的食物。圖 1 顯示二零一二年實時測量環境輻射的地點，圖 2 所示為二零一二年其他環境伽馬輻射的測量地點及環境樣本的收集點。表 1 列載二零一二年的取樣及分析概要。

2.1 環境輻射水平的直接測量

2.1.1 輻射監測網絡

天文台在二零一二年分別於香港西部的赤鱲角及南部的鶴咀建立了兩個新的輻射監測站。輻射監測網絡由原來的十個固定站增加至十二個(圖 1)，以更全面地測量香港境內的環境伽馬輻射水平。

每個輻射監測站均裝設一個高壓電離室(Reuter-Stokes Model RSS-131/RSS-131-ER environmental radiation monitor) ，不斷測量環境伽馬輻射劑量率，並每一分鐘將數據傳送至天文台總部。

天文台在互聯網上發放各監測站錄得的每小時平均環境伽馬輻射劑量率數據，供市民參考，網址為：

http://www.weather.gov.hk/radiation/ermp/rmn/applet/map/rmn_hourly_c.htm

2.1.2 熱釋光劑量計網絡

香港天文台於一九八零年代末開始使用熱釋光劑量計，測量長時間累積的環境伽馬輻射劑量。熱釋光劑量計網絡包括位於香港各區的固定監測點。這個網絡使用 Harshaw 8807 型號的氟化鋰(LiF:Mg,Ti)及氟化鈣(CaF_2:Dy)熱釋光劑量計。為

確保數據的統計精確度，每個監測點均設有五個一組的劑量計。熱釋光劑量計每季更換及取讀數據一次。

為了進一步加強熱釋光劑量計網絡的覆蓋範圍，天文台於二零一二年在青衣青柏樓及赤鱲角輻射監測站增設兩個熱釋光劑量計監測點，使監測點由原來的二十七個增加至二十九個(圖 2)。

同時，天文台在二零一二年於新建之鶴咀輻射監測站增設熱釋光劑量計監測點，並準備以此取代原位於附近鶴咀無線電發射站的監測點，以方便運作及維護，亦可比較同一地點量度到的實時環境伽馬劑量率及累積平均環境伽馬劑量。在二零一二年，鶴咀兩監測點同時運行。

此外，原位於觀塘政府合署內的熱釋光劑量計監測點，由於該建築物需拆卸及重新發展，因此該監測點在二零一二年七月遷移至附近的觀塘輻射監測站。

2.1.3 空中輻射監測系統

香港天文台的空中輻射監測系統於一九九八年開始運作。這系統設有兩組碘化鈉(NaI)探測器，可安裝在政府飛行服務隊的直升機上，以進行測量。它能以輻射煙羽追蹤模式來測定香港上空有否出現輻射煙羽及鑑定其影響範圍。當輻射煙羽經過本港後，該系統也可以轉為地面輻射污染測量模式運作，判別受輻射沉降物污染的地區。進行監測時，該系統可在直升機上即時顯示伽馬圖譜、譜法分析結果及探測位置等資料，並會定時將資料備份。

空中輻射監測系統的優點是它可以在偏遠、陸上交通難以到達的地點進行輻射巡測。每年天文台均會利用空中輻射監測系統以上述兩種模式作常規測量，收集環境輻射水平資料及監測輻射水平隨高度的變化。

2.1.4 自動伽馬譜法系統

自一九九六年起，香港天文台在大鵬灣平洲上設置了一套自動伽馬譜法系統(圖 1) ，以便及早測量核電站可能排放的人工放射性核素。該系統由一個鍍上硫化鋅(ZnS)的塑膠閃爍器、一個高純度鍺探測器和一個碘化鈉探測器組成。系統分別利用一個迴轉空氣濾紙鼓和一個碳濾盒不斷地收集大氣飄塵及氣態碘。碳濾盒每週自動更換一次。硫化鋅閃爍器負責測量大氣飄塵中的總阿爾法及貝他活度；鍺探測器利用伽馬譜法自動分析大氣飄塵釋出的伽馬射線；碘化鈉探測器則量度碳濾盒的碘–131 活度。

系統會每五至十五分鐘將阿爾法和貝他的活度、碘－131 的活度及伽馬譜法分析結果等數據傳送至天文台總部。

2.1.5 流動輻射監測站

流動輻射監測站是一部輻射巡測車，配備多款便攜式及經特別設計的測量儀器，用作常規及應急輻射測量。車頂外置有伽馬探測器和氣管入口，利用這些裝設，測量人員可無需離開車廂便能量度車外的環境伽馬輻射水平及收取空氣樣本。此外，車頂亦裝置了氣象儀器收集天氣數據。

流動輻射監測站日常用於常規巡測、收集樣本及應急演練，並定期到本港指定地點收取環境輻射數據。

2.1.6 高空輻射探測

天文台利用氣球攜帶 Vaisala RS92 型號探空儀及附帶的輻射探測組件在京士柏進行高空輻射探測工作。每個輻射探測組件(Vaisala NSS921 型號)含有兩支蓋革彌勒(Geiger Müller)管，一支是只量度伽馬輻射的伽馬管，另一支是量度伽馬及高於 0.25 兆電子伏(MeV)貝他輻射的伽馬及貝他管。輻射探空儀傳回地面的數據經地面站的一台高空探測系統接收和處理。

天文台每年定期在不同的天氣情況下進行高空輻射探測，以收集輻射水平隨高度變化的數據。

2.2 食物及環境樣本取樣安排

2.2.1 大氣樣本

ERMP 所收集的大氣樣本包括大氣飄塵、濕沉積物(降雨)、總沉積物(濕沉積物加上乾沉積物)、氣態碘及水蒸氣。天文台每週定期在京士柏、沙頭角和元五墳(圖 2)收集一次大氣飄塵和濕沉積物樣本。此外，在其他九個輻射監測站亦裝置有這些儀器，以便在應急時收集大氣樣本。

大氣飄塵是透過高容量空氣取樣器(Hi-Q Environmental Products 4200 AFC-BRL-KIT/230 型號及 Hi-Q Environmental Products BRL-3000M 型號)內的濾紙收集。濕沉積物則由頂部設有漏斗的容器收集。在乾燥季節期內各收集點都會放置三個漏斗容器，以收集足夠雨水作測量。

天文台亦在京士柏收集總沉積物、氣態碘及水蒸氣樣本。總沉積物的取樣器是一個盛有蒸餾水的不銹鋼圓盆，樣本每週收集一次。氣態碘樣本是利用裝有浸滲銀沸石濾盒的放射性碘取樣器(Hi-Q Environmental Products CMP-0523CV/230 型號)收集的，濾盒每週收集和更換一次。

至於水蒸氣樣本，則採用裝有燥石膏濾盒的氣態流出物取樣器(Pylon Electronics Inc. VFP-20 型號)收集，每月隨機選擇一個星期間歇地收集樣本，直至取樣總時數達三十六小時為止。

2.2.2 食物樣本

香港天文台從主要食物分銷點、批發市場和供應商收集各類市民日常食用的陸生和水生食物樣本，並特別著眼於本

港和深圳出產的食物。

2.2.3 飲用水、地下水及海水

經處理的飲用水樣本，是從九龍和屯門配水管，以及沙田、屯門和油柑頭濾水廠(圖 2)收集的。未經處理的飲用水，則從萬宜水庫、船灣淡水湖、木湖 B 抽水站，以及沙田、屯門和油柑頭濾水廠(圖 2)收集。水務署的工作人員每三個月抽取飲用水樣本一次，交香港天文台作輻射測量。

在房屋署職員、屋邨管理員及寺院人員等協助下，天文台於以下六個地點(圖 2)抽取地下水樣本：長康邨(青衣)、鈞樂新村(元朗)、環翠邨(港島東)、華富邨(薄扶林) 、富山邨(東九龍)及清涼法苑(屯門)。

在環境保護署協助下，天文台每年均會抽取海水樣本一次。取樣地點共有四個(圖2)，均位於香港東部沿岸，分別為橫瀾島、火石洲、大浪灣及赤洲附近的海域。海水會從三個不同深度抽取：上層(水面下2.5米)、中層(與水面及海床等距)和低層(海床上2.5米)。海水中的懸浮粒子樣本是經由薄膜過濾海水樣本後收集。

2.2.4 土壤及沉澱物樣本

天文台在香港境內三十九個指定地點抽取土壤樣本，每一地點取樣周期為五年。每個地點抽取的土壤樣本均來自兩個不同的深度：上層由地面至 15 厘米深，下層則由 15 至 30 厘米深。二零一二年的取樣地點為元朗、 尖鼻咀、 石崗、嘉道理農場暨植物園、 長洲、 南丫島、 坪洲及銀礦灣(圖 2)。

潮間帶土樣本每季在白沙灣、尖鼻咀和沙頭角三處沿岸地區(圖 2)收集。樣本從兩個不同深度層抽取，上層從表面至 15 厘米深，下層則自 15 至 30 厘米深。另外，土木工程拓展署每年在大灘海、龍蝦灣、索罟灣和西區碇泊處四個地點(圖

2)協助收取海床沉澱物樣本。

表 1 及表 2 列載二零一二年樣本取樣概要。

2.3 食物及環境樣本的實驗室測量

食物及環境樣本的放射性分析均於京士柏的輻射實驗室進行。表 1 列出監測的主要人工放射性核素。每個樣本按照不同樣本類別及測量目的，經過下列一項或多項程序分析：

(a) 以伽馬譜法測量伽馬放射性核素的活度；
(b) 以液體閃爍計數法測量氚[†]的放射性活度；
(c) 以低本底總貝他計數法測量鍶-90 的放射性活度；及
(d) 以阿爾法譜法測量鈽-239 的放射性活度。

[[†]氚主要是在宇宙射線進入大氣層時自然地形成，或在一九四五至一九八零年間大氣核武試驗中產生，而少量亦可能來自核電站運作（*UNSCEAR 2000*）。]

有關各種量度參數的概要，例如樣本大小、計數時間及探測下限等，載列於表 3。

2.4 本底輻射監測計劃(BRMP)及環境輻射監測計劃(ERMP)的測量值比較

在 2.1 至 2.3 節所敘述的輻射測量中，部份環境伽馬輻射監測站、自動伽馬譜法系統及部分環境及食物樣本的輻射測量在 BRMP 進行的五年間尚未開始運作，所以本報告中有關這些系統或樣本的輻射測量結果並沒有相應的 BRMP 範圍作為本底輻射比對。

雖然如此，自一九九二年 ERMP 第二階段開始運作多年來，所有 BRMP 已包含的輻射測量項目的測量值均顯示香港的環境輻射水平及樣本中的人工放射性核素活度均沒有因

核電廠的運作而產生實質的變化。在這個基礎上，本報告中凡沒有 BRMP 範圍的測量項目(即在 ERMP 第二階段運作後才開始測量的項目)均以該項目首五年測量值的變化範圍作為參考。此參考值的測量時段與 BRMP 最接近，因此在沒有其他可見的變素影響下，也可以被視為該測量項目的近似本底數值範圍。

2.5 質量保證

自一九八九年開始，天文台已參與國際及中國內地機構舉辦的測量比對及能力測試(*許建忠等，2007*)，當中包括國際原子能機構(IAEA)、英國國家物理實驗室(NPL)、世界衛生組織(WHO)及中國輻射防護研究院(CIRP)。

在二零一二年四月天文台參與了國際原子能機構安排就水及泥土樣本進行的實驗室能力測試。同年八月及十一月，天文台參加了中國輻射防護研究院安排的戶外環境伽馬劑量率測量比對，兩次戶外比對地點分別是黑龍江漠河及香港京士柏。詳情見 3.18(b)段。

除了參加測量比對及能力測試外，天文台亦透過內部質量保證程序，確保香港環境輻射監測結果的可靠性。為了提升輻射測量工作的管理效能及品質，天文台輻射實驗室的工作程序是依據國際標準化組織所訂下的 ISO 9001:2008 標準運作和提供輻射測量服務，並於二零零九年初成功獲得認證。

其後認證機構會定期對輻射實驗室作跟進審查，核實其輻射測量服務可繼續獲得 ISO 9001:2008 認證。天文台輻射實驗室於二零一二年一月順利通過第一次三年換證評審，標誌著輻射實驗室所提供的優質輻射測量服務再一次得到認可。

3. 測量結果及結論

3.1 測量結果

3.1.1 輻射監測網絡

輻射監測網絡於二零一二年所錄得的年平均環境伽馬劑量率及一分鐘平均數據的變幅載於表 4a。測量結果均在本底輻射範圍之內。

自輻射監測網絡運作以來，各監測站錄得的輻射水平一般會隨著季節轉變而出現數個百分點的變化。在下雨或當熱帶氣旋影響香港的情況下，變化會明顯較大，甚至高於平時水平的一倍。

二零一二年環境伽馬劑量率的最大變幅於六月十二日錄得。當日香港受雷雨影響，在平洲錄得的一分鐘平均劑量率較該年的平均值高出約一倍半，但仍在本底輻射範圍之內。

3.1.2 熱釋光劑量計網絡

二零一二年各熱釋光劑量計站錄得的伽馬輻射劑量率的年平均值、標準差及變幅載於表 4b。所有監測站錄得的劑量率均在 BRMP 範圍之內。

3.1.3 空中輻射監測系統

在二零一二年八月，空中輻射監測系統以地面輻射污染測量模式在吉澳進行環境輻射測量，測量高度按地勢而改變，並保持着距離地面約一百米。測量過程中並沒有探測到人工放射性核素，測量結果與以往相若。圖 3 為測量當天該區的鉀-40 放射性水平。

天文台於九月使用空中輻射監測系統在大鵬灣及西貢地區以輻射煙羽追蹤模式進行測量。直升機由海拔約一百米升至約一千米，測量海面及地面上的輻射水平隨高度的變化。測量過程中並沒有探測到人工放射性核素。圖4及圖5分別顯示在大鵬灣和西貢地區所錄得的垂直輻射水平分佈數據。一如以往觀測所得，在海面上所量度到的計數率在垂直方向並沒有明顯變化，基本上為本底輻射水平。而在陸地上近地面所量度到的計數率則明顯比海面上的水平高，主要是由於岩石及土壤比海水含有較多放射性物質所致。計數率數值自地面隨高度迅速遞減，直至達到相當於海面上所量度到的水平。

3.1.4 自動伽馬譜法系統

二零一二年平洲自動伽馬譜法系統錄得的數據載於表5。全年並沒有探測到人工放射性核素，而所有測量結果均在環境輻射範圍內。

3.1.5 流動輻射監測站

二零一二年天文台在船灣淡水湖共進行了四次宇宙輻射測量，平均伽馬劑量率為每小時 0.027 至 0.039 微戈(見表6)，與往年所得的數據相近。

3.1.6 高空輻射探測

天文台在二零一二年共進行了四次高空輻射探測。進行探測時的天氣情況如下：四月二十六日部份時間有陽光，地面吹輕微東風。九月六日多雲，地面吹和緩東風。十月十一日天晴，地面吹輕微東南風。十二月六日多雲，地面吹輕微東風。圖 6 顯示二零一二年四次高空輻射探測的平均大氣放射性垂直廓線，數據分析結果與以往大致相若(*李新偉等，2007*)。

3.1.7 食物及環境樣本

二零一二年天文台共收集了 401 個食物和環境樣本。表 7、8、9 和 10 分別列載樣本的伽馬譜法分析、氚、鍶-90 及釷-239 測量結果。

放射性活度數據均按照取樣日期進行衰變修正。倘若取樣工作持續進行了一段較長的時間(例如一週或一月)，衰變修正便會以取樣期間的中間日期作為依據。

各表中只列出有關人工放射性核素的可測量活度結果。為方便參考，表 11 按不同的照射途徑臚列了二零一二年各主要樣本類別的測量結果。

(a) 伽馬譜法分析

二零一二年在部份食物、土壤及沉澱物樣本中發現微量的人工伽馬放射性核素銫-137，活度均在 BRMP 範圍之內。樣本包括海產、土壤、潮間帶土及海床沉澱物，在 BRMP 期間及過往 ERMP 的監測工作中也曾在這幾類樣本中發現銫-137 (*黃明松等，2003*)，相信主要是與一九四五至一九八零年間大氣核武試驗的沉降物殘餘有關(*UNSCEAR 2000)*。

(b) 氚

二零一二年在部份大氣、水及食物樣本中發現微量的氚，活度均在本底輻射範圍之內。樣本包括大氣水蒸氣、濕沉積物、總沉積物、地下水、海水、飲用水、樽裝水、水果、食米、牛奶、蔬菜、家禽、肉類、海產及海藻。所偵測到的氚相信主要是因宇宙射線自然產生，而小部份則是以往大氣核武試驗的殘餘(*UNSCEAR 2000)*。

(c) 鍶-90

二零一二年在部份大氣、食物及土壤樣本中發現微量的鍶-90，活度均在本底輻射範圍之內。這些樣本包括大氣飄

塵、濕沉積物、總沉積物、土壤、食米、牛奶、蔬菜、水果、家禽、肉類、海產、海藻及海水中懸浮粒子。在 BRMP 期間及過往 ERMP 的監測工作中，這些樣本中也曾發現鍶-90，相信主要也是來自以往大氣核武試驗(*UNSCEAR 2000)*。

(d) 鈈-239

二零一二年在部份潮間帶土及海床沉澱物樣本中發現微量的鈈-239，活度均在 BRMP 範圍之內。鈈-239 主要也是來自以往大氣核武試驗的沉降物(*UNSCEAR 2000)*。

3.1.8 測量比對結果

(a) 實驗室測量比對

在二零一二年四月天文台參與了國際原子能機構安排就水及泥土樣本進行的實驗室能力測試，結果待國際原子能機構正式公佈後在將來的香港環境輻射監測摘要中報告。

(b) 戶外環境伽馬劑量率測量比對

天文台在二零一二年參加了中國輻射防護研究院安排的兩次戶外環境伽馬劑量率測量比對。第一次 (八月二十三至二十七日) 比對地點為黑龍江省漠河縣政府辦公大樓東側廣場，第二次 (十一月十五至十八日) 比對地點為香港京士柏氣象站。

比對方法是在以上地點各選取數個測量點量度環境伽馬劑量率，每點量度時間約十五分鐘。兩次比對的參考值為所有參與單位的測量平均值。表 12 為比對結果。

八月在漠河的比對中，天文台使用了沿用的 Reuter-Stokes 型號 RSS-131 高壓電離室進行測量。比對結果顯示天文台的數據與參考數值相符。而於十一月在京士柏的比對中，天文台採用了在近年新購置測量幅度較廣的 RSS-131-ER 高壓電

離室進行測量。比對結果顯示天文台的數據稍為偏高。

經進一步分析後，新的 RSS-131-ER 高壓電離室和沿用的 RSS-131 高壓電離室在一般環境下的性能相近，但在較高伽馬劑量率下則有一些差異。在實驗室以較高伽馬劑量率作刻度檢測時，RSS-131-ER 高壓電離室的測量結果會稍為偏低。於十一月在京士柏的比對中，天文台採用在較高伽馬劑量率刻度檢測時得出的係數(1.117) 為測量數據作相應調整。而分析發現在一般比對環境下，無需採用此係數作調整。因此，若剔除該係數 1.117，天文台的數據便與其他參與單位的數值大為相符。天文台已通知中國輻射防護研究院有關分析結果。

以上表明測量比對的重要性，能有效檢視測量儀器或方法的可能存在差異，並以科學方法分析，得出不同儀器或方法的特點和優劣，務求不斷改進。由於輻射監測網絡採用的 RSS-131 及 RSS-131-ER 型號高壓電離室在一般環境下運行時均沒有作任何調整，因此其日常運作及準確度均不受影響。

3.2 結論

二零一二年在香港境內不同地點錄得的環境伽馬劑量率均在本底輻射範圍之內。與過去的情況相若，天文台在不同的環境及食物樣本中測量到微量的人工放射性核素，包括銫−137、氚、鍶−90 及釙−239。它們的水平與在廣東核電站及嶺澳核電站運作之前所收集的樣本並沒有顯著分別。

從以上結果可推論日本福島核事故並未對本港的環境輻射水平造成長遠影響。而世界衛生組織的有關報告亦顯示日本福島核事故不會在日本以外導致健康風險明顯增加 *(World Health Organization 2013)*。

以此總結，二零一二年香港的環境輻射水平及在環境和食物樣本中的人工放射性核素活度並沒有可測量到的變化。

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CONTENTS

FIGURES

TABLES

1. INTRODUCTION

Since 1961, the Hong Kong Observatory (HKO) has been monitoring environmental radiation levels in Hong Kong and participating in international programmes on environmental radiation monitoring organised by the International Atomic Energy Agency (IAEA) and the World Meteorological Organization (WMO). In response to the construction of nuclear power stations at Daya Bay in Guangdong, the HKO embarked in 1983 on a comprehensive programme to monitor the environmental radiation levels in Hong Kong before and after the power plants commenced operation.

The programme includes the Environmental Radiation Monitoring Programme (ERMP) which consists of two phases. The first phase is known as the Background Radiation Monitoring Programme (BRMP) and was conducted in the 5-year period from 1987 to 1991 to establish the baseline radiation levels in Hong Kong prior to the operation of the Guangdong Nuclear Power Station (GNPS) in 1994 (see Figure 1 for location). These baseline levels would help to reflect any changes arising from the operation of GNPS. The monitoring results can be found in the report on the BRMP (*Hong Kong Observatory 1992*).

The second phase of the ERMP, implemented since 1992, contains all the essential features of the BRMP and with adjustments in sampling and measurement to take advantage of the experience gained. The ERMP is an on-going programme to detect long-term changes in environmental radiation levels in Hong Kong, if any, particularly those arising from the operation of the GNPS and the Lingao Nuclear Power Station (LNPS) since 1994 and 2002 respectively.

The monitoring results of the ERMP can be found in the respective annual reports and summaries (http://www.weather.gov.hk/publica/pubrm.htm). From 2003 onwards, the annual reports only contain the most salient features of the programme, including summaries of measurement methods and results, highlights of new work, changes.or measures introduced during the year. Readers may refer to the relevant reports for details of the sampling, measurement and quality assurance work.

Chapter 2 of this report describes the sampling schedule, the instruments and methods used for measuring ambient radiation levels, radioactivity in food and environmental samples as well as quality assurance. Measurement results of 2012 and conclusions are presented in Chapter 3.

2. SAMPLING, MEASUREMENT AND QUALITY ASSURANCE

The emphasis of the ERMP is to monitor three major exposure pathways, namely the atmospheric pathway, the terrestrial pathway and the aquatic pathway. In respect of measurement, there are two major components. The first component is the direct measurement of ambient radiation levels in Hong Kong. The second is the detection of artificial radioactive material in the environment of Hong Kong and in the foodstuff commonly consumed by Hong Kong people. The locations for real-time measurement of ambient radiation in 2012 are shown in Figure 1. The other locations for measurement of ambient gamma radiation and collection of environmental samples in 2012 are shown in Figure 2. A summary of the sampling and analysis programme of the ERMP in 2012 is given in Table 1.

2.1 Direct measurement of ambient radiation level

2.1.1 Radiation Monitoring Network

In 2012, the Hong Kong Observatory set up two new radiation monitoring stations, one at Chek Lap Kok in the western part of Hong Kong and the other one at Cape D'Aguilar in the southern part of Hong Kong. The number of fixed stations of the radiation monitoring network (RMN) thus increased from 10 to 12 (Figure 1), providing a more comprehensive coverage for measurement of ambient gamma radiation level in Hong Kong.

The dose rates are measured at each station continuously by a high pressure ionization chamber (HPIC) (Reuter-Stokes Model RSS-131/RSS-131-ER environmental radiation monitor). Data are transmitted to the Observatory Headquarters every minute.

The hourly average ambient gamma dose rate data recorded by the radiation monitoring stations are made available on the Internet for reference by the public. The address of the website is:

http://www.weather.gov.hk/radiation/ermp/rmn/applet/map/rmn_hourly_e.htm

2.1.2 Thermoluminescent Dosimeter Network

A thermoluminescent dosimeter (TLD) network has been in operation since the late 1980s to measure ambient gamma doses accumulated over a long period. The network comprises fixed monitoring points over the territory. The TLDs are of the lithium fluoride (LiF:Mg,Ti) and calcium fluoride (CaF_2:Dy) type (Harshaw 8807). A batch of five TLDs is placed at each site to ensure statistical accuracy. The TLDs

are replaced and read on a quarterly basis.

To further enhance the coverage of the TLD network, the Observatory established two additional TLD monitoring points in 2012, one at Ching Pak House in Tsing Yi and the other at Chek Lap Kok Radiation Monitoring Station. The number of monitoring points increased from 27 to 29 (Figure 2).

In 2012, an additional TLD monitoring point was established at the new Cape D'Aguilar Radiation Monitoring Station. The new monitoring point is to replace the TLD monitoring point originally located at the nearby Cape D'Aguilar Radio Transmitting Station to facilitate operation and maintenance. This will also make possible direct comparison between real time ambient gamma dose rate and accumulated mean ambient gamma dose at the same location. The two TLD monitoring points at Cape D'Aguilar operated concurrently in 2012.

Besides, due to demolition and re-development of the Kwun Tong Government Offices, the TLD monitoring point originally located there was moved to the nearby Kwun Tong Radiation Monitoring Station in July 2012.

2.1.3 Aerial Radiation Monitoring System

The Aerial Radiation Monitoring System (ARMS) has been put into operation since 1998. The system consists of two assemblies of sodium iodide (NaI) detectors that can be mounted on board a helicopter of the Government Flying Service for operation. When operating in the plume tracking mode, it has the capability to determine the existence and extent of any radioactive plume over Hong Kong. After the passage of the plume, the system using the ground contamination measurement mode can be used to identify surface areas contaminated by deposited radionuclides. Gamma spectra, spectroscopic analysis results and location information are displayed on board the helicopter in real time and archived at regular intervals.

The merit of ARMS is that it can be used to detect radiation levels over remote areas and over regions inaccessible to land transportation. Every year, ARMS will operate in the two modes described above for routine measurement to collect data of environmental radiation level as well as radiation levels at various altitudes.

2.1.4 Automatic Gamma Spectrometry System

Hong Kong Observatory has been operating the Automatic Gamma Spectrometry System (AGSS) at Ping Chau, Mirs Bay since 1996 (Figure 1) for providing early alert of any releases of artificial radionuclides from the nuclear power stations. The system consists of a zinc sulphide (ZnS) coated plastic scintillator, a high purity germanium detector and a NaI detector. It continuously collects airborne particulates on a rotating filter drum and gaseous iodine in a carbon cartridge.

The carbon cartridge is replaced automatically at weekly intervals. The ZnS scintillator measures the gross alpha and beta activities of the particulates collected. The germanium detector measures gamma rays emitted by the particulates and gamma spectrometry analysis is carried out automatically. The NaI detector measures the iodine-131 concentration in the carbon cartridge.

Data of alpha and beta activities, iodine-131 activity, as well as results of gamma spectrometry analysis are transmitted to the Observatory Headquarters every 5 to 15 minutes.

2.1.5 Mobile Radiation Monitoring Station

The Mobile Radiation Monitoring Station (MRMS) is a radiological survey vehicle that is equipped with portable and specially designed instruments for use in routine and emergency radiological surveys. An external gamma probe and an air inlet on the vehicle roof provide the means to measure the ambient gamma radiation levels outside the vehicle and to collect air samples without the survey team members having to leave the vehicle. In addition, meteorological instruments installed on top of the vehicle are used to collect weather data.

The radiological survey vehicle is deployed for routine radiological survey, collection of samples and emergency drills. It also pays regular visits to selected locations in Hong Kong to collect environmental radiation data.

2.1.6 Upper-air Radioactivity Soundings

Radioactivity in the upper atmosphere is measured at King's Park by radioactivity sensors attached to balloon-borne radiosondes (Model Vaisala RS92). The radioactivity sensor (Model Vaisala NSS921) comprises two Geiger-Müller (GM) tubes: a gamma-only tube, which measures only gamma radiation, and a gamma-plus-beta tube, which measures gamma as well as beta radiation of energy higher than 0.25 MeV. Data from the radioactivity sensor is transmitted back and processed by the upper-air sounding system at the ground station.

The Observatory carried out regular radioactivity soundings under different weather conditions each year to collect data of the variation of radiation levels with altitudes.

2.2 Collection of food and environmental samples

2.2.1 Atmospheric Samples

Atmospheric samples, including airborne particulates, wet deposition

(precipitation), total deposition (wet plus dry deposition), gaseous iodine and water vapour, are collected under ERMP. Airborne particulates and wet depositions are regularly collected at King's Park, Sha Tau Kok and Yuen Ng Fan (Figure 2) at weekly intervals. In addition, equipment is also installed at the other nine radiation monitoring stations for collecting atmospheric samples during emergency.

Airborne particulates are collected from a filter paper installed inside a high volume air sampler (Hi-Q Environmental Products Model 4200 AFC-BRL-KIT/230 and Hi-Q Environmental Products Model BRL-3000M). Wet deposition is collected by a carboy fitted with a top funnel. During the dry season, three sets of carboys and funnels are used at each location for collection of sufficient amount of rain for measurement.

Total deposition, gaseous iodine and water vapour are also collected at King's Park. The sampler for total deposition is a stainless-steel pan partially filled with distilled water to collect samples at weekly intervals. Gaseous iodine is sampled through a silver impregnated zeolite cartridge fitted inside a radioiodine sampler (Hi-Q Environmental Products Model CMP-0523CV/230), which is collected and replaced weekly.

Water vapour is collected using a gaseous effluent sampler (Pylon Electronics Inc. Model VFP-20) with a drierite cartridge operated intermittently during a week-long period randomly selected in each calendar month, until the overall collection time reaches 36 hours.

2.2.2 Food Samples

Terrestrial and aquatic food samples typical of the diet of the local population are collected at main distribution points, wholesale markets and from enlisted suppliers. Particular attention has been given to food produced locally and in Shenzhen.

2.2.3 Drinking Water, Underground Water and Sea Water

Treated drinking water is collected from distribution taps at Kowloon and Tuen Mun as well as the treatment works at Shatin, Tuen Mun and Yau Kom Tau (Figure 2). Untreated or raw drinking water is collected from the High Island Reservoir, the Plover Cove Reservoir, the Muk Wu B Pumping Station and the treatment works at Shatin, Tuen Mun and Yau Kom Tau (Figure 2). Both treated and untreated drinking water samples are collected once every three months by staff of the Water Supplies Department. The drinking water samples are passed to the Observatory for radiological measurements.

Underground water is collected at six locations (Figure 2), namely Cheung Hong Estate (Tsing Yi), Kwan Lok San Tsuen (Yuen Long), Wan Tsui Estate (East Hong

Kong Island), Wah Fu Estate (Pokfulam), Fu Shan Estate (East Kowloon) and Ching Leung Nunnery (Tuen Mun) with assistance from the Housing Department, the respective estate management and the nunnery personnel.

With the assistance of the Environmental Protection Department, sea water is sampled annually at four locations over the eastern part of the coastal waters of Hong Kong (Figure 2), namely waters off Waglan Island, Basalt Island, Tai Long Wan and Port Island. At each location, samples are collected at three depths - the upper level (2.5 metres underneath the surface), the middle level (equidistant from the surface and the seabed) and the lower level (2.5 metres above the seabed). Suspended particulates in sea water are collected by filtering the sea water samples through a membrane filter.

2.2.4 Land Soil and Sediments

Land soil is sampled at 39 designated sites throughout the territory. Each site is sampled once every five years. At each site, samples were collected from two layers, the upper layer from the surface to 15 cm deep and the lower layer from 15 cm to 30 cm deep. In 2012, land soil samples were collected from Yuen Long, Tsim Bei Tsui, Shek Kong, Kadoorie Farm and Botanic Garden, Cheung Chau, Lamma Island, Peng Chau, and Silvermine Bay (Figure 2).

Intertidal sediments are sampled quarterly at three locations along the coast of Hong Kong (Figure 2), namely Pak Sha Wan, Tsim Bei Tsui and Sha Tau Kok. Two layers are taken at each sampling point, the upper layer from the surface to 15 cm deep and the lower layer from 15 cm to 30 cm deep. Sampling of seabed sediments is carried out annually with the assistance of the Civil Engineering and Development Department at four locations over the coastal waters of Hong Kong (Figure 2), namely Tai Tan Hoi, Lung Ha Wan, Picnic Bay and Western Anchorage.

The sampling and analysis programme in 2012 is summarized in Table 1 and 2.

2.3 Measurement of food and environmental samples in laboratory

All radioactivity measurements of food and environmental samples are carried out in the Radiation Laboratory at King's Park. A list of the major artificial radionuclides routinely monitored is given in Table 1. Each sample, depending on the sample type and measurement objective, will go through one or more of the following analyses:

(a) gamma spectrometry analysis to determine the activities of gamma-emitting radionuclides;
(b) liquid scintillation counting to determine the activity of tritium[†];

(c) low-level gross beta counting to determine the activity of strontium-90; and

(d) alpha spectrometry analysis to determine the activity of plutonium-239.

[†Tritium is primarily produced naturally by cosmic rays entering the atmosphere or generated during atmospheric nuclear weapon tests conducted from 1945 to 1980. A small amount is also produced during the operation of nuclear power stations (*UNSCEAR 2000*).]

A summary of key measurement parameters, including sample size, counting time and detection limits, are given in Table 3.

2.4 Comparison between BRMP and ERMP measurement results

Among the radiation measurement works described in Section 2.1 to 2.3, some of the radiation monitoring stations, the Automatic Gamma Spectrometry System as well as radiological measurements of some of the environmental and food samples had not yet started operation during the BRMP 5-year period. Hence for the measurement results from these systems or samples, no corresponding BRMP ranges are available as background reference.

Despite this, during the years of operation since the start of the second phase of ERMP in 1992, results of BRMP-covered radiation measurement of ambient radiation levels and activities of artificial radionuclides suggested that there had been no material changes in the overall environmental radiation levels in Hong Kong as a result of the operation of the nuclear power plants. On this basis, for radiation measurement without BRMP reference values (i.e. measurement started after the second phase of ERMP), the range of values in the first five years of measurement were adopted as the reference range in this report. This reference range, being closest to the BRMP period in time, can effectively be taken as the approximate baseline level of that radiation measurement in the absence of visible influences from other variables.

2.5 Quality assurance

Since 1989, the Observatory has been participating in inter-laboratory comparison exercises and proficiency tests organized by major international and national organizations (*Hui et al., 2007*), namely the International Atomic Energy Agency (IAEA), the National Physical Laboratory of the United Kingdom (NPL), the World Health Organization (WHO) and the China Institution for Radiation Protection (CIRP).

In April 2012, the Observatory participated in the laboratory proficiency test for

water and soil samples organized by IAEA. The Observatory also participated in the inter-comparison exercise on field measurement of ambient gamma dose rate organised by CIRP at Mohe, Heilongjiang and at King's Park, Hong Kong in August and November 2012 respectively. Details of the inter-comparison exercises are given in Section 3.18(b).

Other than inter-laboratory comparison exercises and proficiency tests, the quality of the environmental radiation monitoring results in Hong Kong is also assured through internal quality assurance procedures. To enhance the management efficiency and quality of its radiation measurement work, the Hong Kong Observatory Radiation Laboratory adheres to a high standard of radiation measurement services based on the International Organisation for Standardization ISO 9001:2008. Accreditation for the ISO 9001:2008 was obtained in early 2009.

The certification body will conduct annual surveillance audits of the Radiation Laboratory to ascertain that its radiation measurement services meet the requirements for the continuation of ISO 9001:2008 certification. The Radiation Laboratory successfully passed the first re-certification audit in January 2012, three years after ISO accreditation. This reaffirmed the quality radiation measurement services provided by the Observatory's Radiation Laboratory.

3. RESULTS AND CONCLUSION

3.1 Results

3.1.1 Radiation Monitoring Network

The annual average ambient gamma dose rates and ranges of 1-minute averages recorded by the RMN in 2012 are tabulated in Table 4a. The measurement results were all within baseline radiation levels.

Since the operation of the RMN, temporal changes in the radiation level recorded at the stations are typically a few per cent in seasonal variations. During rainy condition or episodes of tropical cyclone affecting Hong Kong, the variations can be significantly larger and may even double the usual level.

The most significant change in the ambient gamma dose rate in 2012 was recorded on 12 June. Under the influence of thundery showers, the 1-minute average dose rate at Ping Chau rose to about 1.5 times above the mean value of the year, but still within the baseline levels.

3.1.2 Thermoluminescent Dosimeter Network

The annual average, standard deviation and range of gamma dose rates measured

at each of the TLD stations in 2012 are listed in Table 4b. The gamma dose rates recorded at all stations were found to be within the BRMP range.

3.1.3 Aerial Radiation Monitoring System

In August 2012, ambient radiation measurement in the ground contamination measurement mode was conducted by ARMS over Kat O. The measurement height followed terrain, maintained at a height of about 100 metres above the ground. No artificial radionuclides were detected and measurement results obtained were similar to those in the past. Figure 3 shows the radioactivity level of potassium-40 over the area on the day of measurement.

In September, measurement flights in the plume tracking mode were carried out over Mirs Bay and Sai Kung areas. The helicopter rose from about 100 metres up to about 1000 metres above sea level to measure the change of radiation levels against altitude over the sea surface and land surface. No artificial radionuclides were detected. Figure 4 and 5 depict the vertical radiation level profiles over Mirs Bay and Sai Kung area respectively. Similar to past observations, the count rates arising from gamma rays over the sea areas reflected basically the background radiation levels and showed no significant changes with height. On the other hand, the count rates measured near land surface was significantly higher than those measured over the sea surface, as rocks and soil contained more radioactive substances than sea water. The count rates over land decreased rapidly with height before reaching a level close to those measured over the sea.

3.1.4 Automatic Gamma Spectrometry System

Results obtained by the AGSS in 2012 are given in Table 5. No artificial radionuclides were detected in the year and all results were within ranges of environmental radiation levels.

3.1.5 Mobile Radiation Monitoring System

Four measurements of cosmic radiation were carried out at Plover Cove in 2012. The average gamma dose rates ranged from 0.027 to 0.039 μGy h^{-1} (Table 6), close to those measured in previous years.

3.1.6 Upper-air Radioactivity Soundings

Four radioactivity soundings were made in 2012. The weather conditions during these soundings were: sunny periods with light easterly winds at the surface on 26 April; cloudy with moderate easterly winds at the surface on 6 September; fine with light southeasterly winds at the surface on 11 October and cloudy with light easterly winds at the surface on 6 December. Figure 6 shows the average vertical profiles of atmospheric radioactivity from the four upper-air radioactivity soundings

in 2012. The data analysis results obtained were similar to those in the past (*Li et al. 2007*).

3.1.7 Food and Environmental Samples

A total of 401 food and environmental samples were collected in 2012. The results of gamma spectrometry analyses, tritium measurements, strontium-90 measurements and plutonium-239 measurements are shown in Tables 7, 8, 9 and 10 respectively.

All radioactivity data are decay-corrected to the date of sampling. Where sampling is done over an extended period (for instance a week or a month), decay correction is made with reference to the mid-point of the sampling period.

Only results pertaining to measurable activities of artificial radionuclides are included in all tables. For ease of reference, a summary of measurement results in 2012 for the major sample types according to different pathways is given in Table 11.

(a) Gamma Spectrometry Analyses

Traces of caesium-137, an artificial gamma-emitting radionuclide, were detected in some food, soil and sediment samples in 2012. The measured activities in these samples were all within the corresponding ranges of BRMP values. The samples included seafood, land soil, intertidal sediment and seabed sediment. Caesium-137 was detected in such sample types in both BRMP and ERMP (*Wong et al. 2003*). The presence of the radionuclide in environmental and food samples could generally be attributed to the remnants of fallout from atmospheric nuclear weapon tests conducted from 1945 till 1980 (*UNSCEAR 2000*).

(b) Tritium

Very small amounts of tritium were detected in some atmospheric, water and food samples in 2012. The measured activities in these samples were all within the baseline radiation levels. The samples include water vapour in air, wet deposition, total deposition, underground water, sea water, drinking water, bottled water, fruits, rice, milk, vegetables, poultry, meat, seafood and seaweed. The source of tritium in the samples was attributable primarily to the natural cosmogenic processes with small contribution from the remnants of fallout from atmospheric nuclear weapon tests (*UNSCEAR 2000*).

(c) Strontium-90

Traces of strontium-90 were detected in some atmospheric, food and soil samples in 2012. The activities in these samples were within the baseline

radiation levels. The samples included airborne particulates, wet deposition, total deposition, land soil, rice, milk, vegetables, fruits, poultry, meat, seafood, seaweed and suspended particulate in sea water. Strontium-90 was detected in such sample types in both BRMP and ERMP. The radionuclide's presence was also primarily attributable to atmospheric nuclear tests in the past (*UNSCEAR 2000*).

(d) Plutonium-239

Minute amounts of plutonium-239 were detected in some intertidal sediment and seabed sediment samples in 2012. The measured activities in these samples were all within the BRMP range. Fallout from past atmospheric nuclear weapon tests could again be the major source of plutonium-239 (*UNSCEAR 2000*).

3.1.8 Inter-comparison Results

(a) Inter-comparison on Laboratory Measurement

In April 2012, the Observatory participated in the laboratory proficiency test for water and soil samples organized by the IAEA. Results of the test will be presented in future annuary summary of environmental radiation monitoring in Hong Kong upon the official publication of the results by the IAEA.

(b) Inter-comparison on Field Measurement of Ambient Gamma Dose Rate

In 2012, the Observatory participated in two inter-comparison exercises on field measurement of ambient gamma dose rate organised by CIRP. The first exercise was conducted between 23 and 27 August at an open area to the east of the Government Office Building in Mohe, Heilongjiang. The second exercise was held between 15 and 18 November at King's Park Meteorological Station in Hong Kong.

The inter-comparison methodology was to select several survey points at each site for measurement of the ambient gamma dose rates for a period of about 15 minutes. The mean of the measurement results from all participants was used as the reference value at each survey point. A summary of the inter-comparison results is given in Table 12.

During the inter-comparison exercise at Mohe in August, the Observatory used the Reuter-Stokes Model RSS-131 HPIC, which had been in use for quite some time, to conduct the measurements. The results showed that the measurements made by the Observatory were consistent with the reference values. During the inter-comparison exercise at King's Park in November, the Observatory used a recently procured RSS-131-ER HPIC with wider measurement range for the measurements. The measurement results from that equipment were relatively higher than the others.

After further analysis, it was found that the performance of the new

RSS-131-ER HPIC is similar to that of the long adopted RSS-131 HPIC when operating in ambient environment. However, in relatively higher gamma dose rate environment, performances of the two models were a bit different. For instance, when operating in a relatively higher gamma dose rate laboratory environment during calibration checks, measurement results of RSS-131-ER HPIC were found to be slightly lower. In the inter-comparison exercise at King's Park in November, the Observatory had used a multiplying factor of 1.117, which was obtained from the calibration check, to adjust the measurement data of RSS-131-ER HPIC. Investigations revealed that the adjustment was not needed when the HPIC operated in ambient environment for inter-comparison purpose. With the removal of the factor 1.117, the measurement results of the Observatory were basically in line with the results from the other participating organizations. CIRP has been informed of the relevant analysis results.

The above demonstrates the importance of inter-comparison exercise in identifying potential differences in instrumentation or methodology. Through scientific analysis, the characteristics, strengths and weaknesses of different instruments or methods are understood with a view to achieving continuous improvement in measurements. As no adjustment is made to both RSS-131 and RSS-131-ER HPIC in ambient environment in the radiation monitoring network, daily operation and accuracy of the HPIC are not affected.

3.2 Conclusion

The ambient gamma dose rates recorded over various parts of the territory in 2012 were within the baseline radiation levels. As in the past years, traces of artificial radionuclides, namely caesium-137, tritium, strontium-90 and plutonium-239, were detected in various environmental and food samples. The levels of all these radionuclides were not significantly different from those recorded before the Guangdong Nuclear Power Station and Lingao Nuclear Power Station came into operation.

It can be inferred from the above results that the Fukushima nuclear accident in Japan did not bring any long-term effect to the ambient radiation levels in Hong Kong. According to World Health Organization (*World Health Organization 2013*), no discernible increase in health risks from the Fukushima nuclear accident is expected outside Japan too.

It is concluded that in 2012 there was no measurable change in ambient radiation levels and in activities of artificial radionuclides in the Hong Kong environment and foodstuffs consumed by Hong Kong people.

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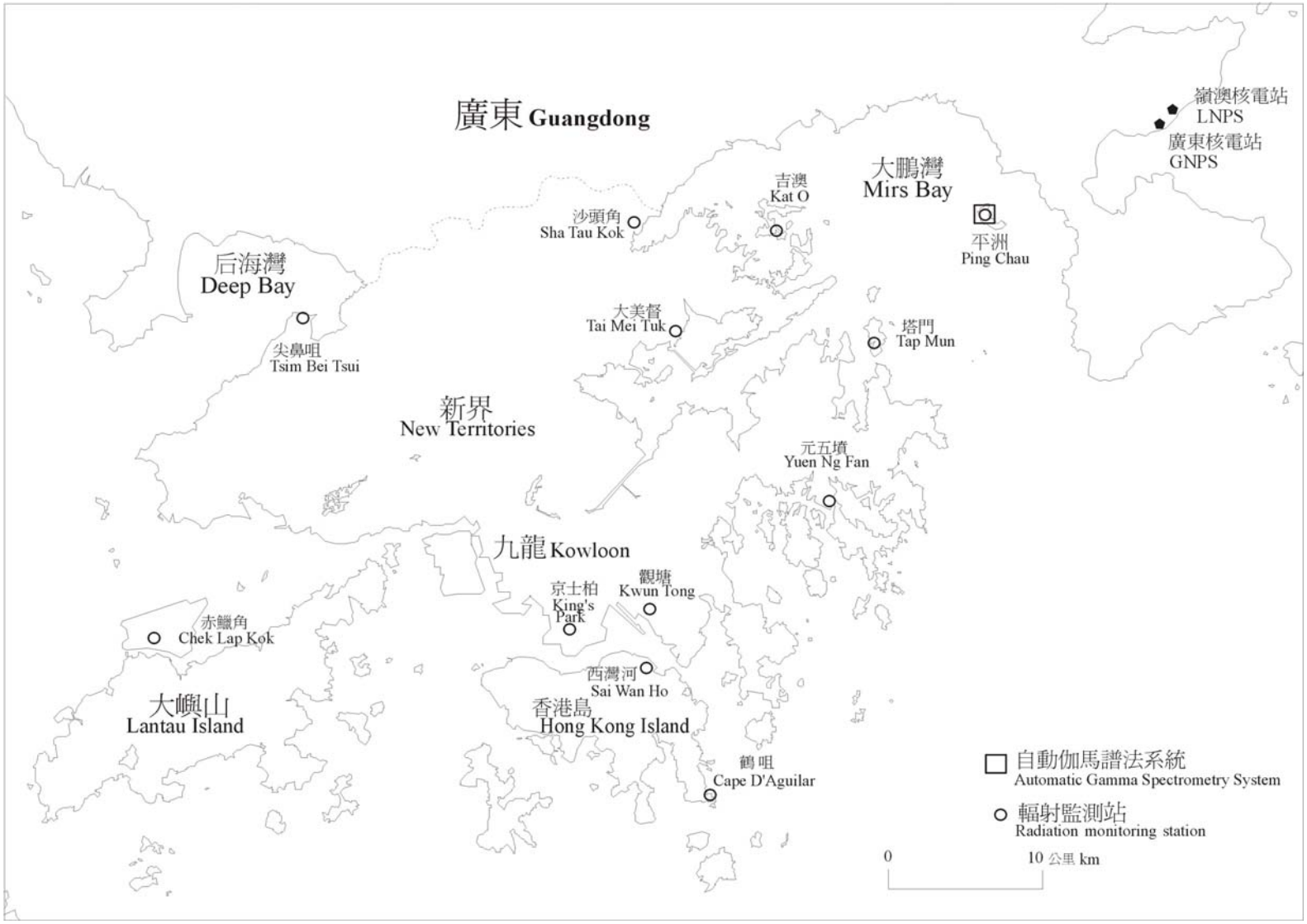

圖1. 二零一二年實時監測環境輻射的測量點。

Figure 1. Locations for real-time measurement of ambient radiation in 2012.

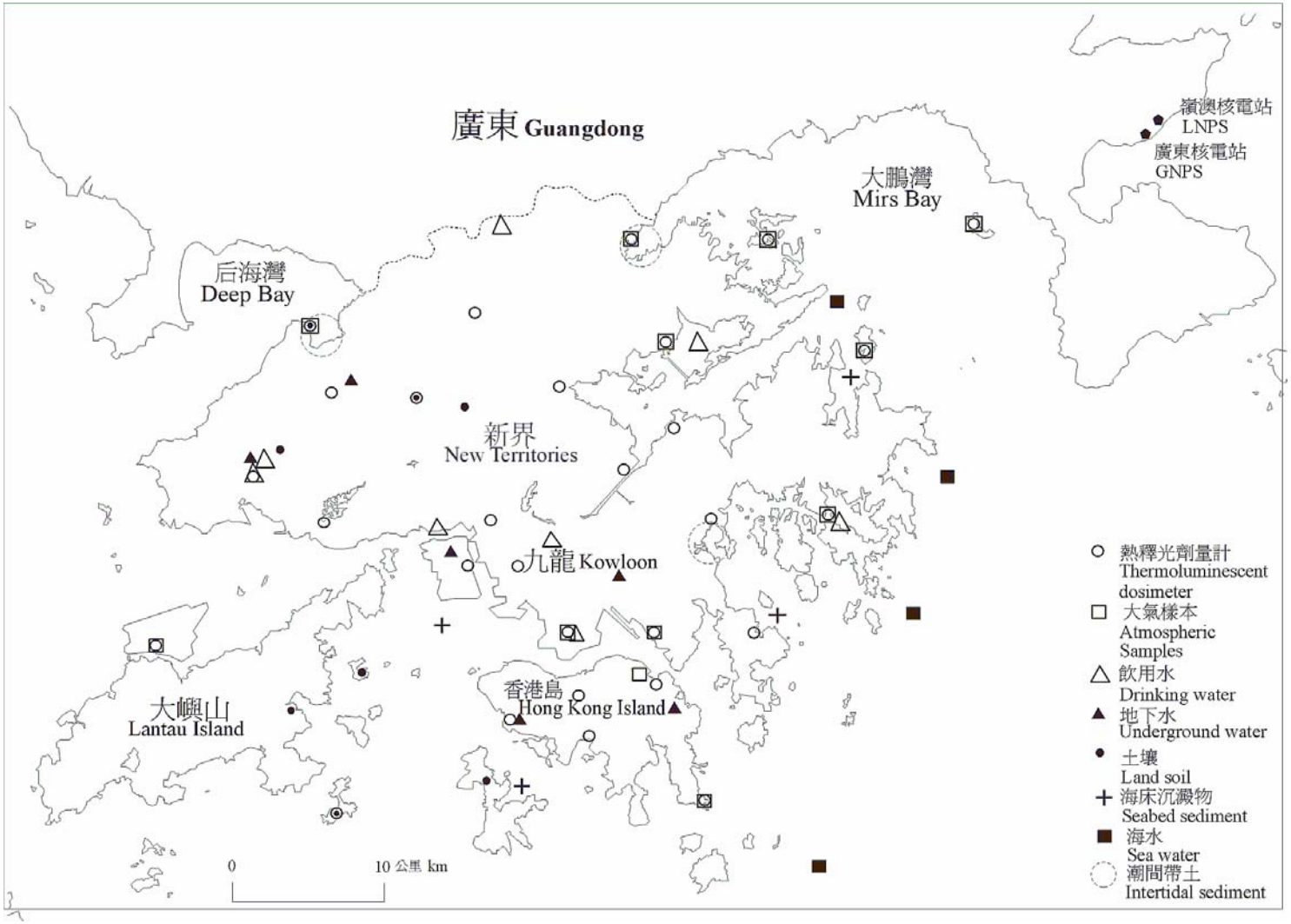

圖 2. 熱釋光劑量計網絡及二零一二年環境樣本收集點。

Figure 2. Thermoluminescent dosimeter network and locations for collection of environmental samples in 2012.

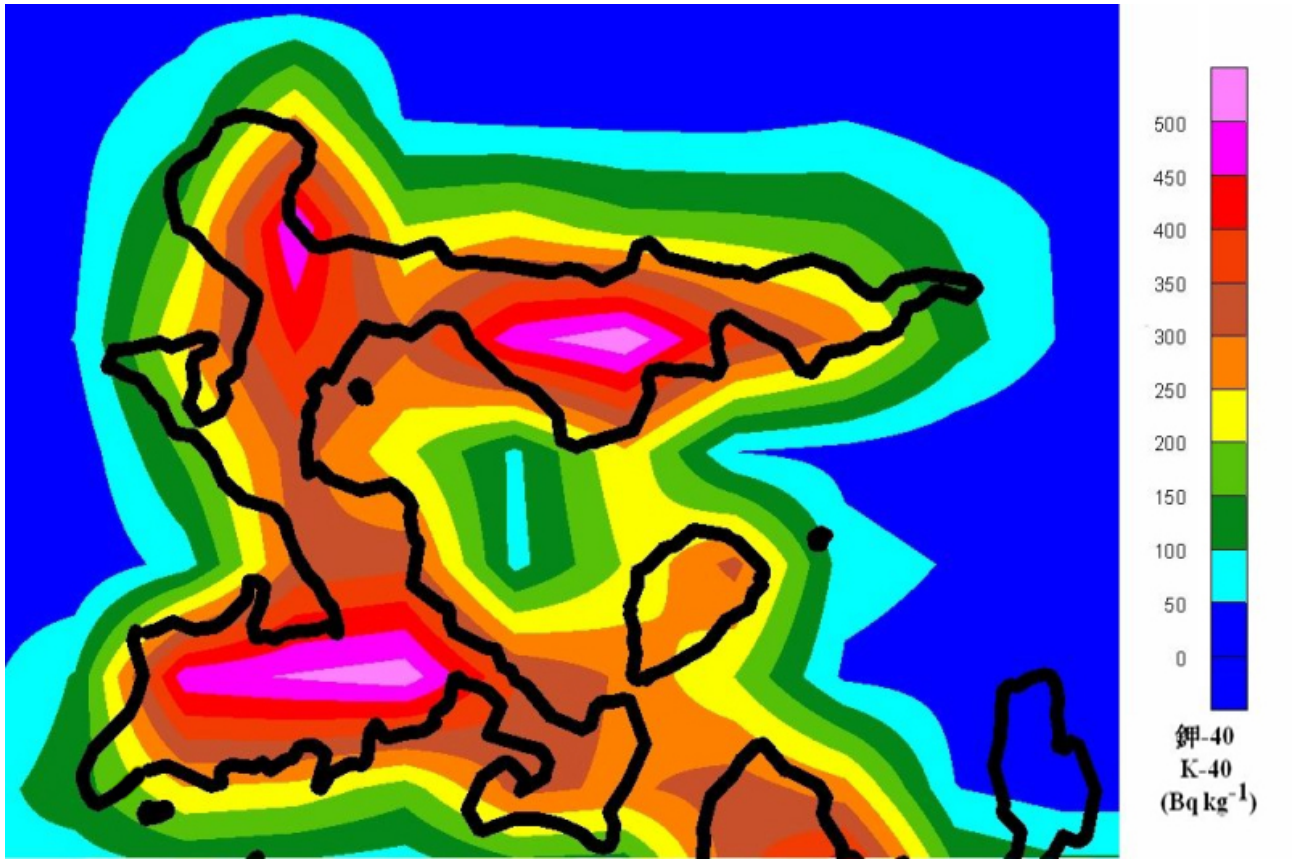

圖 3. 空中輻射監測系統在吉澳上空測量到的鉀-40 放射性水平 (測量高度距離地面約一百米)(二零一二年八月十四日)。

Figure 3. Radioactivity level of Potassium-40 over Kat O, as measured by the Aerial Radiation Monitoring System at about 100 metres above the ground on 14 August 2012 .

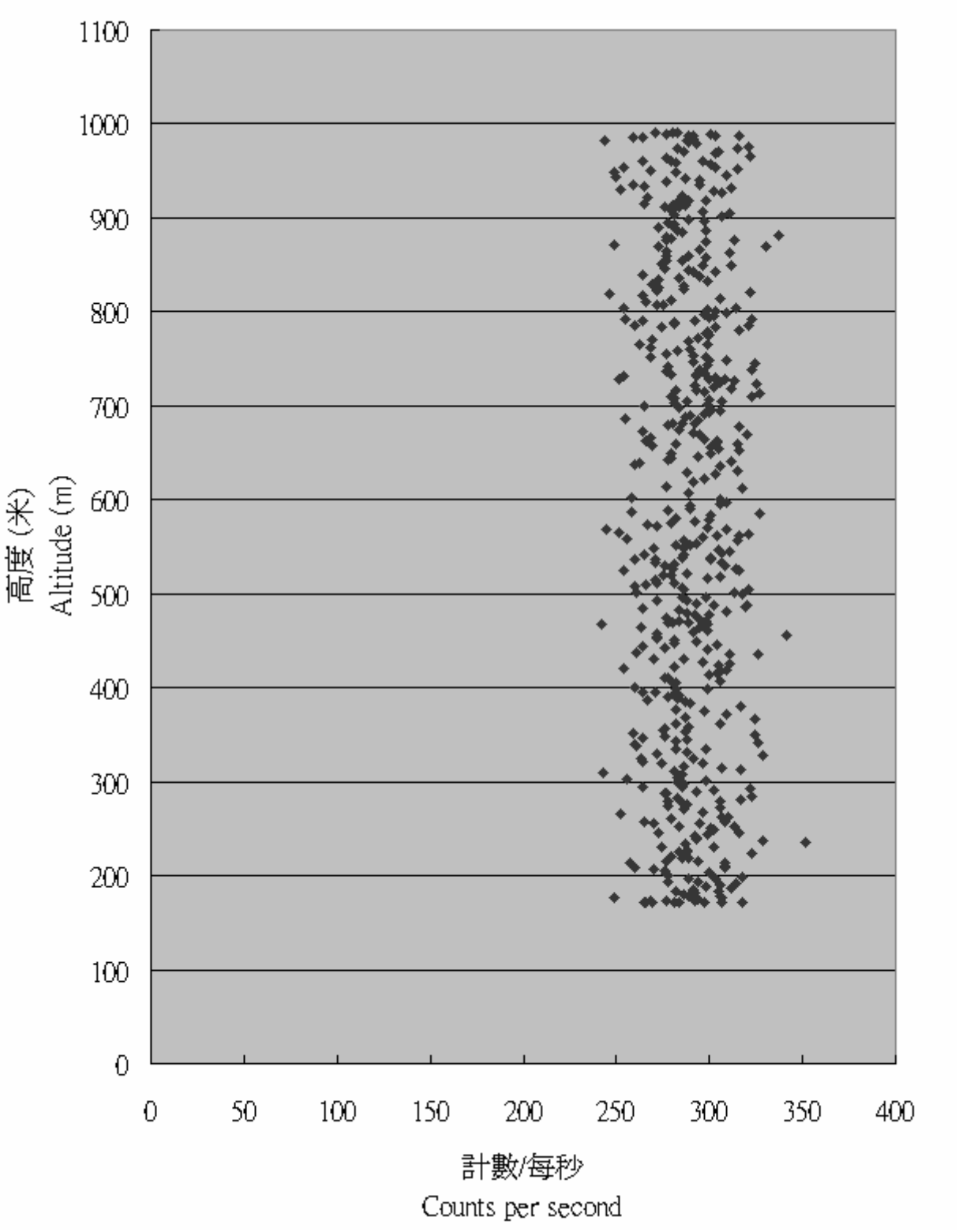

圖4. 空中輻射監測系統在大鵬灣海面上空測量到的計數率隨高度的變化 (二零一二年九月四日)。

Figure 4. Variation of count rate with altitude at Mirs Bay, as measured by the Aerial Radiation Monitoring System on 4 September 2012.

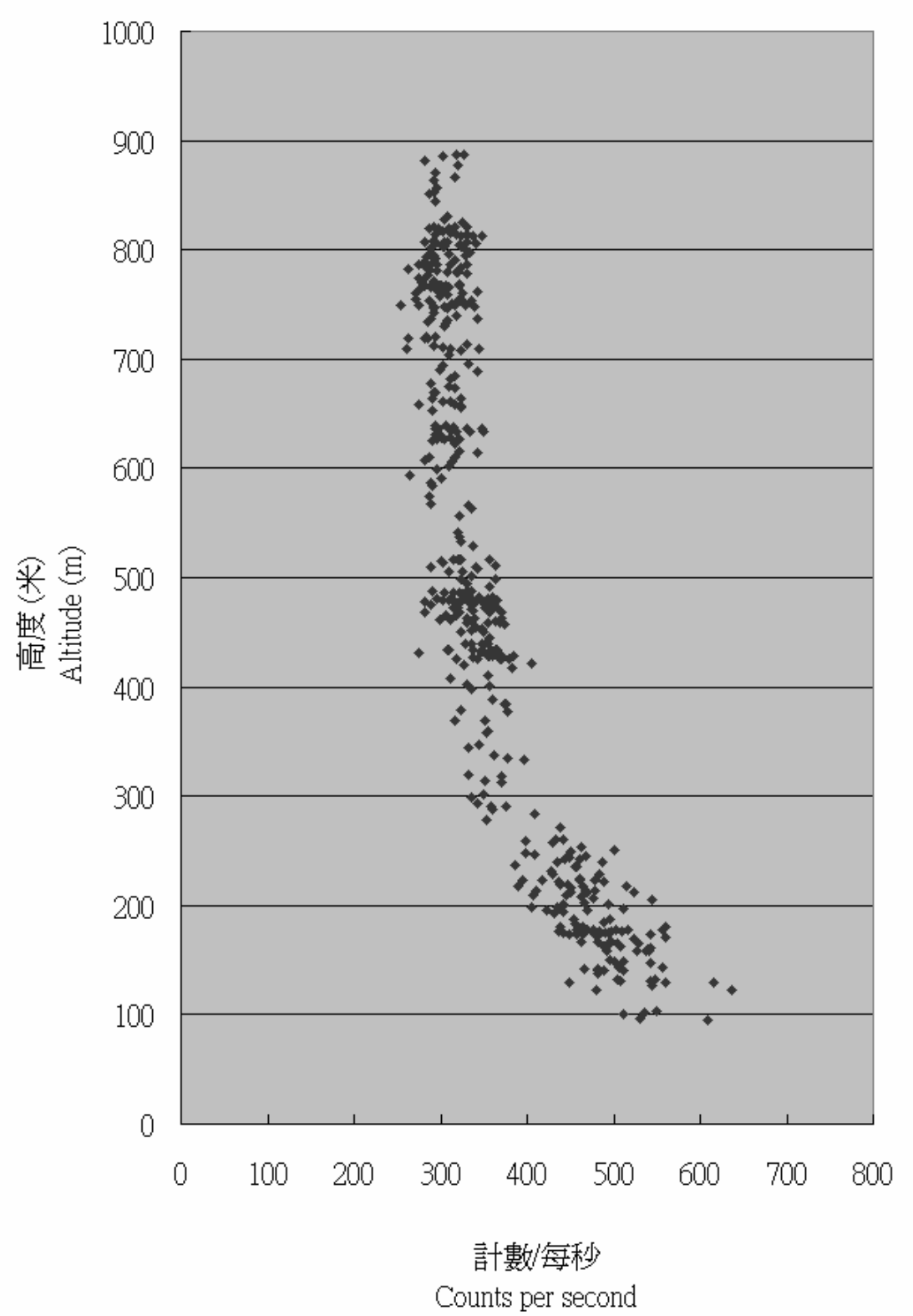

圖5. 空中輻射監測系統在西貢地區上空測量到的計數率隨高度的變化 (二零一二年九月四日)。

Figure 5. Variation of count rate with altitude at Sai Kung area, as measured by the Aerial Radiation Monitoring System on 4 September 2012.

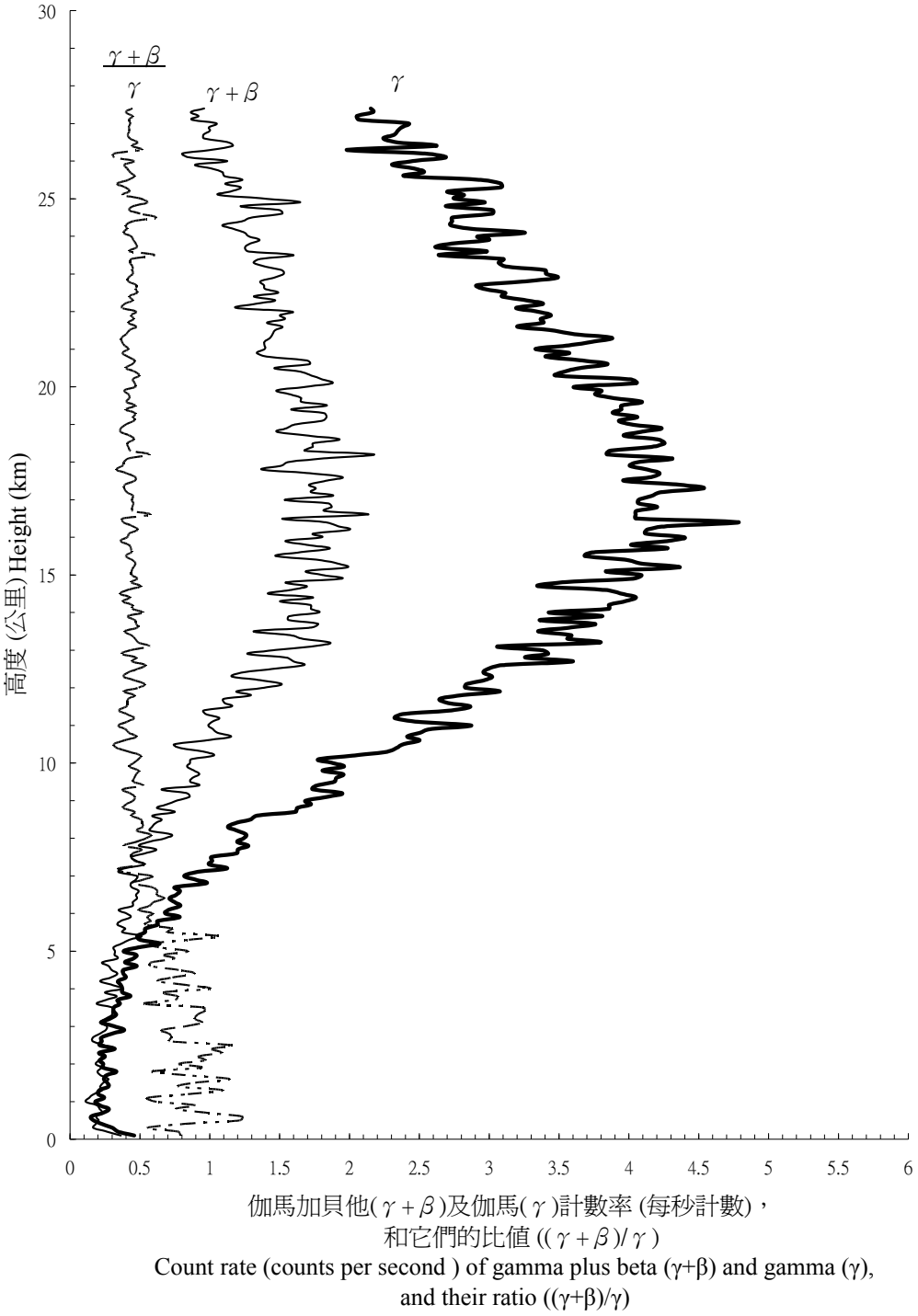

圖6. 二零一二年內在京士柏進行的四次高空輻射探測之平均大氣放射性垂直廓線(探測日期爲：四月二十六日、九月六日、十月十一日及十二月六日)。

Figure 6. Average vertical profiles of atmospheric radioactivity from four upper-air radioactivity soundings conducted at King's Park in 2012 (dates of sounding: 26 April, 6 September, 11 October and 6 December).

表 1.　二零一二年樣本取樣及分析概要

Table 1.　Summary of the sampling and analysis programme in 2012

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
環境伽馬輻射 Ambient Gamma Radiation				
伽馬劑量率 Gamma dose rates	平洲 Ping Chau, 塔門 Tap Mun, 吉澳 Kat O, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan, 大美督 Tai Mei Tuk, 尖鼻咀 Tsim Bei Tsui, 觀塘 Kwun Tong, 西灣河 Sai Wan Ho, 京士柏 King's Park 鶴咀 Cape D'Aguilar 赤鱲角 Chek Lap Kok	12	伽馬 γ	一分鐘 1-minute interval
累積伽馬劑量 Cumulative gamma doses	平洲 Ping Chau, 塔門 Tap Mun, 吉澳 Kat O, 元五墳 Yuen Ng Fan, 清水灣 Clear Water Bay, 西貢 Sai Kung, 大美督 Tai Mei Tuk, 烏溪沙 Wu Kai Sha, 鶴咀 Cape D'Aguilar, 沙頭角 Sha Tau Kok, 沙田 Shatin, 觀塘 Kwun Tong, 筲箕灣 Shau Kei Wan, 大埔 Tai Po, 京士柏 King's Park, 跑馬地 Happy Valley, 深水灣 Deep Water Bay, 石梨貝 Shek Lei Pui, 置富花園 Chi Fu Fa Yuen, 粉嶺 Fanling, 荃灣 Tsuen Wan, 石崗 Shek Kong, 長洲 Cheung Chau, 元朗 Yuen Long, 大欖涌 Tai Lam Chung, 尖鼻咀 Tsim Bei Tsui, 屯門 Tuen Mun 赤鱲角 Chek Lap Kok 青衣 Tsing Yi	29	伽馬 γ	每季 quarterly

表1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
大氣樣本 Atmospheric Samples				
大氣飄塵 Airborne particulate	京士柏 King's Park, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan	3	伽馬 γ, 鍶-90 Sr-90, 鈈-239 Pu-239	每週(累積一月) weekly (bulked monthly) *(每週樣本只進行伽馬分析 Weekly sample for γ analysis only)*
濕沉積物(降雨) Wet deposition (precipitation)	京士柏 King's Park, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan	3	伽馬γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每週 (累積一月作分析) weekly (bulked monthly for analysis)
總沉積物 Total deposition	京士柏 King's Park	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每週 (累積一月作分析) weekly (bulked monthly for analysis)
氣態碘 Gaseous iodine	京士柏 King's Park	1	伽馬 γ	每週 weekly
大氣水蒸氣 Water vapour in air	京士柏 King's Park	1	氚 H-3	每月 monthly
地面樣本 Terrestrial Samples				
食米 Rice	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen, 沙頭角 Sha Tau Kok	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
菜心 Choi sum	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
白菜 Pak choi	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
香蕉 Banana	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
荔枝 Lychee	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	夏季 summer
柑橘 Mandarin	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	秋季及冬季 autumn and winter
甘蔗 Sugar cane	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	春季 spring
雞 Chicken	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
鴨 Duck	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
牛肉 Beef	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
豬肝 Pig's liver	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
豬肉 Pork	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly

表 1. (續)

Table 1. (cont'd)

樣本類別 **Sample type**	取樣地點 **Sampling location**	地點數目 **Number of location**	分析類別 **Type of analysis**	取樣頻率 **Sampling frequency**
土壤 (上層及下層) Land soil (upper and lower level)	京士柏 King's Park, 沙田 Shatin, 西貢 Sai Kung, 清水灣 Clear Water Bay, 萬宜水庫西 High Island West, 萬宜水庫東 High Island East, 北潭凹 Pak Tam Au, 白沙澳 Pak Sha O, 大埔 Tai Po, 粉嶺 Fanling, 沙頭角 Sha Tau Kok, 大美督 Tai Mei Tuk, 城門水塘 Shing Mun Reservoir, 荃灣 Tsuen Wan, 大欖涌水塘 Tai Lam Chung Reservoir, 青山發電廠 Castle Peak Power Station, 元朗 Yuen Long*, 尖鼻咀 Tsim Bei Tsui*, 石崗 Shek Kong*, 嘉道理農場暨植物園 Kadoorie Farm and Botanic Garden*, 長洲 Cheung Chau*, 南丫島 Lamma Island*, 坪洲 Peng Chau*, 銀礦灣 Silvermine Bay* 東涌 Tung Chung, 石壁水塘 Shek Pik Reservoir, 大澳 Tai O, 白泥 Pak Nai, 塔門 Tap Mun, 吉澳 Kat O, 平洲 Ping Chau, 跑馬地 Happy Valley, 薄扶林水塘 Pokfulam Reservoir, 香港仔下水塘 Lower Aberdeen Reservoir, 深水灣 Deep Water Bay, 大潭水塘 Tai Tam Reservoir, 鶴咀 Cape D'Aguilar, 牛頭角配水庫 Ngau Tau Kok Service Reservoir, 石梨貝水塘 Shek Lei Pui Reservoir	39	伽馬 γ, 鍶-90 Sr-90, 鈈-239 Pu-239	每一地點每 5 年採樣一次 Each location is sampled once every 5 years. * 2012 年採樣地點 * locations sampled in 2012

表 1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
飲用水(經處理) Drinking water (treated)	九龍配水管 Kowloon distribution tap, 屯門配水管 Tuen Mun distribution tap, 沙田濾水廠 Shatin Treatment Works, 屯門濾水廠 Tuen Mun Treatment Works, 油柑頭濾水廠 Yau Kom Tau Treatment Works	5	伽馬 γ, 氚 H-3	每季 quarterly
飲用水(未經處理) Drinking water (untreated)	萬宜水庫 High Island Reservoir, 船灣淡水湖 Plover Cove Reservoir, 木湖 B 抽水站 Muk Wu B Pumping Station, 沙田濾水廠 Shatin Treatment Works, 屯門濾水廠 Tuen Mun Treatment Works, 油柑頭濾水廠 Yau Kom Tau Treatment Works	6	伽馬 γ, 氚 H-3	每季 quarterly
樽裝水(蒸餾水) Bottled water (Distilled)	本地 Local	1	伽馬 γ, 氚 H-3	每季 quarterly
樽裝水(礦泉水) Bottled water (Mineral)	本地 Local	1	伽馬 γ, 氚 H-3	每季 quarterly
地下水 Underground water	長康邨 Cheung Hong Estate, 鈞樂新村 Kwan Lok San Tsuen, 環翠邨 Wan Tsui Estate, 華富邨 Wah Fu Estate, 富山邨 Fu Shan Estate, 清涼法苑 Ching Leung Nunnery	6	伽馬 γ, 氚 H-3	每年 yearly
海水(上層、中層及低層) Sea water (upper, middle and lower level)	橫瀾島 Waglan Island, 火石洲 Basalt Island, 大浪灣 Tai Long Wan, 赤洲 Port Island	4	伽馬 γ, 氚 H-3	每年 yearly
海水中懸浮粒子 (上層、中層及低層) Suspended particulate in sea water (upper, middle and lower level)	橫瀾島 Waglan Island, 火石洲 Basalt Island, 大浪灣 Tai Long Wan, 赤洲 Port Island	4	伽馬 γ, 鍶-90 Sr-90, 鈈-239 Pu-239	每年 yearly

表1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
大魚 *Aristichthys nobilis* (Big-head carp)	深圳 Shenzhen, 元朗 Yuen Long	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
瓜三 *Nemipterus japonicus* (Melon coat)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
牛鮸 *Platycephalus indicus* (Bartail flathead)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
牙帶 *Trichiurus haumela* (Hair tail)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
赤米蝦 *Metapenaeopsis barbata* (Fire prawn)	香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
魷魚 *Loligo edulis* (Squid)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
墨魚 *Sepia spp.* (Cuttlefish)	香港水域 Hong Kong Waters	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
蜆 *Tapes philippinarum* (Clam)	長洲 Cheung Chau, 吐露港 Tolo Harbour	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau, 吐露港 Tolo Harbour, 大亞灣 Daya Bay	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
東風螺 *Babylonia formosae* (Gastropod)	香港水域 Hong Kong Waters	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
石蒓 *Ulva lactuca* (Sea lettuce)	布袋澳 Po Toi O	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季及春季 winter and spring

表1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
滸苔 *Enteromorpha prolifera* (Sea hair)	吐露港 Tolo Harbour	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季 winter
長紫菜 *Porphyra dentata* (Red algae)	蒲台島 Po Toi Island	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季 winter
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季及春季 winter and spring
潮間帶土(上層及下層) Intertidal sediment (upper and lower level)	白沙灣 Pak Sha Wan, 尖鼻咀 Tsim Bei Tsui, 沙頭角 Sha Tau Kok	3	伽馬 γ, 鈈-239 Pu-239	每季 quarterly
海床沉澱物 Seabed sediment	大灘海 Tai Tan Hoi, 龍蝦灣 Lung Ha Wan, 索罟灣 Picnic Bay, 西區碇泊處 Western Anchorage	4	伽馬 γ, 鈈-239 Pu-239	每年 yearly

表2. 二零一二年食物樣本概要

Table 2. Summary of food samples in 2012

類別 Type	**地點 Location**	**收集樣本總數 Total no. of sample collected**
食米 Rice	內地(珠江三角洲) Mainland (Pearl River Delta)	4
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	4
	沙頭角 Sha Tau Kok	4
菜心 Choi sum	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
白菜 Pak choi	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
香蕉 Banana	內地(廣東) Mainland (Guangdong)	4
荔枝 Lychee	內地 Mainland	1
柑橘 Mandarin orange	內地(廣東) Mainland (Guangdong)	2
甘蔗 Sugar cane	內地(廣東) Mainland (Guangdong)	1
雞 Chicken	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
鴨 Duck	內地(深圳) Mainland (Shenzhen)	4
牛肉 Beef	內地 Mainland	4
豬肝 Pig's Liver	內地(廣東) Mainland (Guangdong)	4
	本地 Local	4
豬肉 Pork	內地(廣東) Mainland (Guangdong)	4
	本地 Local	4
大魚 *Aristichthys nobilis* (Big-head carp)	深圳 Shenzhen	3
	元朗 Yuen Long	3
瓜三 *Nemipterus japonicus* (Melon coat)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
牛鰍 *Platycephalus indicus* (Bartail flathead)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
牙帶 *Trichiurus haumela* (Hair tail)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3

表2. (續)

Table 2. (cont'd)

類別 Type	地點 Location	收集樣本總數 Total no. of sample collected
赤米蝦 *Metapenaeopsis barbata* (Fire prawn)	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
魷魚 *Loligo edulis* (Squid)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
墨魚 *Sepia spp.* (Cuttlefish)	香港水域 Hong Kong Waters	3
蜆 *Tapes philippinarum* (Clam)	長洲 Cheung Chau	1
	吐露港 Tolo Harbour	3
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau	3
	吐露港 Tolo Harbour	3
	大亞灣 Daya Bay	3
東風螺 *Babylonia formosae* (Gastropod)	香港水域 Hong Kong Waters	3
石蒓 *Ulva lactuca* (Sea lettuce)	布袋澳 Po Toi O	2
滸苔 *Enteromorpha prolifera* (Sea hair)	吐露港 Tolo Harbour	1
長紫菜 *Porphyra dentata* (Red algae)	蒲台島 Po Toi Island	0
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	2

表 3. 二零一二年樣本之主要量度參數概要(1)

Table 3. Summary of key measurement parameters for samples in 2012(1)

測量類別 Measurement type		樣本大小 Sample size	計數時間(秒) Counting time (second)	本底 Background (CPM)	計數效率 Counting efficiency (%)	化學復得率 Chemical recovery (%)	探測下限(2) Minimum Detectable Activity(2) (MDA)		
							碘-131 I-131	銫-137 Cs-137	銫-134 Cs-134
伽馬放射性核素 Gamma emitting radionuclides	大氣飄塵 Airborne particulate	12000 m^3 (累積每月樣本 bulked monthly sample)	55000	-	-	-	10 μBq m^{-3}	10 μBq m^{-3}	10 μBq m^{-3}
		3000 m^3 (每週樣本 weekly sample)	20000				50 μBq m^{-3}	50 μBq m^{-3}	100 μBq m^{-3}
							碘-131 I-131	銫-137 Cs-137	
	氣態碘 Gaseous Iodine	400 m^3	55000	-	-	-	300 μBq m^{-3}	-	
	濕沉積物 Wet deposition	4 L	55000	-	-	-	0.2 Bq L^{-1}	0.2 Bq L^{-1}	
	總沉積物 Total deposition	0.03 m^2	55000	-	-	-	15 Bq m^{-2}	15 Bq m^{-2}	
	食米 Rice	4 kg	20000	-	-	-	0.2 Bq kg^{-1}	0.2 Bq kg^{-1}	
	牛奶 Milk	1 L	55000	-	-	-	0.2 Bq L^{-1}	0.3 Bq L^{-1}	
	蔬菜 Vegetable	1 kg	20000	-	-	-	0.3 Bq kg^{-1}	0.4 Bq kg^{-1}	
	水果 Fruit	2 kg	20000	-	-	-	0.3 Bq kg^{-1}	0.3 Bq kg^{-1}	
	家禽 Poultry	2 kg	20000	-	-	-	0.2 Bq kg^{-1}	0.2 Bq kg^{-1}	
	肉類 Meat	1 kg	20000	-	-	-	0.4 Bq kg^{-1}	0.4 Bq kg^{-1}	
	土壤 Land soil	1 kg	20000	-	-	-	1.0 Bq kg^{-1}	1.5 Bq kg^{-1}	
	水樣本 Water samples	4 L	55000	-	-	-	0.1 Bq L^{-1}	0.1 Bq L^{-1}	
	海水中懸浮粒子 Suspended particulate	5 L	55000	-	-	-	0.02 Bq L^{-1}	0.02 Bq L^{-1}	
	海產 Seafood	2 kg	72000	-	-	-	0.1 Bq kg^{-1}	0.1 Bq kg^{-1}	
	海藻 Seaweed	0.5 kg	20000	-	-	-	1 Bq kg^{-1}	2 Bq kg^{-1}	
	潮間帶土/海床沉澱物 Sediment	2 kg	20000	-	-	-	0.5 Bq kg^{-1}	0.5 Bq kg^{-1}	

表 3. (續)

Table 3. (cont'd)

測量類別 Measurement type		樣本大小 Sample size	計數時間(秒) Counting time (second)	本底 Background (CPM)	計數效率 Counting efficiency (%)	化學復得率 Chemical recovery (%)	探測下限[2] Minimum Detectable Activity[2] (MDA)
氚 Tritium	濕沉積物 Wet deposition	0.007 L	18000	2	25	-	4 Bq L^{-1}
	總沉積物 Total deposition	0.0001 m^2	18000	2	25	-	300 Bq m^{-2}
	水蒸氣 Water vapour	2 m^3	18000	2	25	-	0.01 Bq m^{-3}
	食米 Rice	0.08 kg	18000	2	25	-	0.3 Bq kg^{-1}
	牛奶 Milk	0.007 L	18000	2	25	-	4 Bq L^{-1}
	蔬菜 Vegetable	0.008 kg	18000	2	25	-	3 Bq kg^{-1}
	水果 Fruit	0.01 kg	18000	2	25	-	3 Bq kg^{-1}
	家禽 Poultry	0.01 kg	18000	2	25	-	3 Bq kg^{-1}
	肉類 Meat	0.01 kg	18000	2	25	-	3 Bq kg^{-1}
	水樣本 Water samples	0.007 L	18000	2	25	-	4 Bq L^{-1}
	地下水 Underground water	0.1 L	18000	2	25	-	0.3 Bq L^{-1}
	海產 Seafood	0.02 kg	18000	2	25	-	1 Bq kg^{-1}
	海藻 Seaweed	0.05 kg	18000	2	25	-	1 Bq kg^{-1}
鍶-90 Strontium-90	大氣飄塵 Airborne particulate	5000 m^3	30000	1	75	90	1 μ Bq m^{-3}
	濕沉積物 Wet deposition	2 L	30000	1	75	100	0.002 Bq L^{-1}
	總沉積物 Total deposition	0.01 m^2	30000	1	75	100	0.5 Bq m^{-2}
	米 Rice	3 kg	30000	1	75	90	0.002 Bq kg^{-1}
	牛奶 Milk	1 L	30000	1	75	90	0.005 Bq L^{-1}
	蔬菜 Vegetable	1 kg	30000	1	75	90	0.005 Bq kg^{-1}
	水果 Fruit	2 kg	30000	1	75	90	0.003 Bq kg^{-1}
	家禽 Poultry	2 kg	30000	1	75	90	0.003 Bq kg^{-1}
	肉類 Meat	1 kg	30000	1	75	90	0.005 Bq kg^{-1}
	土壤 Land soil	0.005 kg	30000	1	75	90	1 Bq kg^{-1}
	海水中懸浮粒子 Suspended particulate	3 L	30000	1	75	90	0.002 Bq L^{-1}
	海產 Seafood	1.5 kg	30000	1	75	90	0.004 Bq kg^{-1}
	海藻 Seaweed	0.05 kg	30000	1	75	90	0.1 Bq kg^{-1}

表 3 (續)

Table 3. (cont'd)

測量類別 Measurement type		樣本大小 Sample size	計數時間(秒) Counting time (second)	本底 Background (CPM)	計數效率 Counting efficiency (%)	化學復得率 Chemical recovery (%)	探測下限(2) Minimum Detectable Activity(2) (MDA)
鈽-239 Plutonium-239	大氣飄塵 Airborne particulate	6000 m^3	220000	0.003	20	40	0.2 μ Bq m^{-3}
	濕沉積物 Wet deposition	2 L	220000	0.003	20	60	0.0004 Bq L^{-1}
	總沉積物 Total deposition	0.01 m^2	220000	0.003	20	60	0.07 Bq m^{-2}
	土壤 Land soil	0.003 kg	220000	0.003	20	50	0.3 Bq kg^{-1}
	海水中懸浮粒子 Suspended particulate	3 L	220000	0.003	20	50	0.0003 Bq L^{-1}
	海產 Seafood	0.5 kg	220000	0.003	20	40	0.002 Bq kg^{-1}
	海藻 Seaweed	0.05 kg	220000	0.003	20	60	0.01 Bq kg^{-1}
	潮間帶土 / 海床沉澱物 Sediment	0.003 kg	220000	0.003	20	50	0.3 Bq kg^{-1}

註:

(1) 表內所列是 ERMP 在二零一二年主要量度參數的典型數值，僅供參考之用。視乎實際操作情況，量度參數可能有變化。在特別情況下，部份樣本會使用與上表頗爲不同的參數進行量度。

(2) 測量的探測下限是指一個測量系統在該次測量時實際能測量到的最低活度水平。探測下限的數值取決於多個因數，包括個別測量系統的特質、測量方法、樣本的特質及測量的情況，所以探測下限會隨著個別樣本和測量而改變。表內所示的探測下限爲在一般測量情況下的典型數值，僅供在理解此報告的結果時作簡易參考之用。有時在個別樣本的測量情況下，可能測量出遠低於探測下限的活度水平。

Note:

(1) The values given in the table are typical values of key measurement parameters in the ERMP in 2012. The values may vary in practice, and should thus be used as reference only. Under special circumstances, some samples may be measured under substantially different conditions.

(2) The minimum detectable activity (MDA) of a measurement is the lowest activity level that is practically achievable by the counting system for that measurement. MDA values depend on the characteristics of the measurement system, method of measurement, sample characteristics and measurement conditions, and thus vary with individual samples and measurements. The listed MDAs are typical values under "typical" measurement conditions and serve as a quick reference in interpreting results in this report. Under individual measurement conditions, activity much lower than the typical MDA would sometimes be measured.

表 4a. 輻射監測網絡在二零一二年錄得的環境伽馬劑量率。(單位爲每小時微戈)

Table 4a. Ambient gamma dose rates recorded by the radiation monitoring network in 2012 (dose rate in μGy h^{-1})

輻射監測站 Radiation Monitoring Station	**年平均值 Annual Average**	**標準差 Standard Deviation**	**一分鐘平均值範圍 Range of 1-min Average**
吉澳 Kat O	0.103	0.004	0.089 – 0.148
京士柏 King's Park	0.135	0.003	0.113 – 0.185
觀塘 Kwun Tong	0.125	0.002	0.114 – 0.167
平洲 Ping Chau	0.092	0.005	0.075 – 0.232
西灣河 Sai Wan Ho	0.096	0.002	0.086 – 0.129
沙頭角 Sha Tau Kok	0.101	0.003	0.089 – 0.190
大美督 Tai Mei Tuk	0.116	0.002	0.106 – 0.190
塔門 Tap Mun	0.083	0.003	0.066 – 0.162
尖鼻咀 Tsim Bei Tsui	0.131	0.002	0.070 – 0.197
元五墳 Yuen Ng Fan	0.117	0.003	0.097 – 0.176
赤鱲角 Chek Lap Kok (1)	0.149	0.003	0.132 – 0.190
鶴咀 Cape D'Aguilar (2)	0.134	0.004	0.121 – 0.208
參考範圍(3) Reference Range (3)			0.062 – 0.271

註: (1) 赤鱲角輻射監測站錄得的伽馬劑量率是二零一二年五月一日至十二月三十一日期間的數據。

(2) 鶴咀輻射監測站錄得的伽馬劑量率是二零一二年五月一日至十二月三十一日期間的數據。

(3) 參考範圍爲一九九二至一九九六年輻射監測網絡錄得的環境伽馬劑量率範圍。

Note: (1) The gamma dose rate recorded at Chek Lap Kok radiation monitoring station during the period 1 May to 31 December in 2012.

(2) The gamma dose rate recorded at Cape D'Aguilar radiation monitoring station during the period 1 May to 31 December in 2012.

(3) Reference range is the ambient gamma dose rates recorded by the radiation monitoring network from 1992 to 1996.

表 4b. 熱釋光劑量計網絡在二零一二年錄得的環境伽馬劑量率。(單位爲每小時微戈)

Table 4b. Ambient gamma dose rates recorded by the thermoluminescent network in 2012 (dose rate in μGy h^{-1})

熱釋光劑量計監測點 TLD Location		**年平均值 Annual Average**	**標準差 Standard Deviation**	**範圍 Range**
鶴咀[1] Cape D'Aguilar[1]	無線電發射站 Radio Transmitting Station	0.13	0.01	0.12 – 0.14
	輻射監測站 Radiation Monitoring Station	0.14	0.02	0.13 – 0.17
赤鱲角 Chek Lap Kok		0.14	0.01	0.14 – 0.16
長洲 Cheung Chau		0.12	0.01	0.11 – 0.12
置富花園 Chi Fu Fa Yuen		0.15	0.01	0.14 – 0.16
清水灣 Clear Water Bay		0.10	0.01	0.10 – 0.11
深水灣 Deep Water Bay		0.13	0.01	0.12 – 0.15
粉嶺 Fanling		0.11	0.01	0.10 – 0.12
跑馬地 Happy Valley		0.09	0.01	0.08 – 0.09
吉澳 Kat O		0.11	0.01	0.10 – 0.12
京士柏 King's Park		0.15	0.01	0.14 – 0.17
觀塘[2] Kwun Tong[2]	政府合署 Government Offices	0.16	0.01	0.15 – 0.17
	輻射監測站 Radiation Monitoring Station	0.12	<0.01	0.12 – 0.12
平洲 Ping Chau		0.12	0.01	0.11 – 0.13
西貢 Sai Kung		0.12	0.01	0.11 – 0.14
沙頭角 Sha Tau Kok		0.09	0.01	0.08 – 0.10
BRMP 參考數值[3] BRMP Reference Values[3]				0.03 – 0.29

表 4b. (續)

Table 4b. (cont'd)

熱釋光劑量計監測點 TLD Location	年平均值 Annual Average	標準差 Standard Deviation	範圍 Range
沙田 Shatin	0.13	0.01	0.12 – 0.14
筲箕灣 Shau Kei Wan	0.14	0.01	0.13 – 0.15
石崗 Shek Kong	0.11	<0.01	0.11 – 0.12
石梨貝 Shek Lei Pui	0.20	0.01	0.19 – 0.20
大欖涌 Tai Lam Chung	0.18	<0.01	0.18 – 0.18
大美督 Tai Mei Tuk	0.14	0.01	0.13 – 0.15
大埔 Tai Po	0.10	0.01	0.09 – 0.11
塔門 Tap Mun	0.09	0.01	0.09 – 0.10
尖鼻咀 Tsim Bei Tsui	0.13	0.01	0.12 – 0.13
青衣 Tsing Yi	0.14	0.02	0.12 – 0.16
荃灣 Tsuen Wan	0.13	0.01	0.12 – 0.14
屯門 Tuen Mun	0.14	0.01	0.14 – 0.15
烏溪沙 Wu Kai Sha	0.13	0.01	0.12 – 0.14
元朗 Yuen Long	0.11	<0.01	0.11 – 0.11
元五墳 Yuen Ng Fan	0.12	0.01	0.12 – 0.13
BRMP 參考數值[3] **BRMP Reference Values[3]**			0.03 – 0.29

註: (1) 天文台在二零一二年於新建之鶴咀輻射監測站增設熱釋光劑量計監測點，並準備以此取代原位於附近鶴咀無線電發射站的監測點，以方便運作及維護，亦可比較同一地點量度到的實時環境伽馬劑量率及累積平均環境伽馬劑量。在二零一二年，鶴咀兩監測點同時運行。

(2) 由於觀塘政府合署需拆卸及重新發展，該熱釋光劑量計監測點在二零一二年七月遷移至附近的觀塘輻射監測站。觀塘政府合署所錄得的爲二零一二年第一及第二季的數據，而觀塘輻射監測站所錄得的爲二零一二年第三及第四季的數據。

(3) BRMP參考數值爲熱釋光劑量計網絡於BRMP期間所錄得的伽馬劑量率的範圍。

Note: (1) In 2012, an additional TLD monitoring point was established at the new Cape D'Aguilar Radiation Monitoring Station. The new monitoring point is to replace the TLD monitoring point originally located at the nearby Cape D'Aguilar Radio Transmitting Station to facilitate operation and maintenance. This will also make possible direct comparison between real time ambient gamma dose rate and accumulated mean ambient gamma dose at the same location. The two TLD monitoring points at Cape D'Aguilar operated concurrently in 2012.

(2) Due to demolition and re-development of Kwun Tong Government Offices, the TLD monitoring point originally located there was moved to the nearby Kwun Tong Radiation Monitoring Station in July 2012. The data recorded at Kwun Tong Government Offices TLD monitoring point represented the first and second quarters of 2012, whereas the data recorded at Kwun Tong Radiation Monitoring Station represented the third and fourth quarters of 2012.

(3) BRMP reference values represent the range of the ambient gamma dose rates recorded by the thermoluminescent dosimeter network during BRMP.

表 5. 平洲自動伽馬譜法系統在二零一二年的輻射測量結果

Table 5. Results of measurement by the Automatic Gamma Spectrometry System at Ping Chau in 2012

	年平均值 Annual Average	**標準差 Standard Deviation**	**日平均值範圍 Range of Daily Average**	**首五年(一九九七至二零零一年)參考範圍[1] Reference range from first 5 years of operation (1997 - 2001) [1]**
阿爾法粒子 Alpha (每立方米貝可 Bq m^{-3})	1.3	0.2	1.0 – 1.8	1.0 – 5.8
貝他粒子 Beta (每立方米貝可 Bq m^{-3})	2.1	0.9	1.0 – 5.0	1.0 – 10.1
碘-131 I-131 (每立方米毫貝可 mBq m^{-3})	< 4	N/A[2]	N/A	< 4[3]
銫-137 Cs-137 (每立方米毫貝可 mBq m^{-3})	< 4	N/A	N/A	< 4
氣態碘-131 Gaseous I-131 (每立方米貝可 Bq m^{-3})	< 1	N/A	N/A	< 1

註: (1) 自動伽馬譜法系統的主要目的是測量人工放射性核素。一般情況下，其阿爾法粒子和貝他粒子數值顯示該系統在環境中所錄得的變化，而並非環境中阿爾法及貝他粒子的含量。

(2) N/A 表示不適用。

(3) 測量結果低於探測下限以 "< xx" 表示，xx是該類測量的典型探測下限值。

Note: (1) Automatic Gamma Spectrometry System aims at detecting artificial radionuclides. In general, the alpha and beta values obtained by the system indicate the variations as depicted by the system in the environment, rather than the concentration of alpha and beta activities in the environment.

(2) N/A means 'Not applicable'.

(3) Results below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement.

表6. 二零一二年宇宙輻射引致的伽馬劑量率測量結果 (測量地點: 船灣淡水湖)

Table 6. Measurement results of gamma dose rates due to cosmic radiation in 2012 (measurement site: Plover Cove)

測量日期 Date of measurement	**平均伽馬劑量率(每小時微戈) Average gamma dose rate (μGy h^{-1})**
二零一二年一月二十七日 27 Jan 2012	0.039
二零一二年四月十三日 13 Apr 2012	0.031
二零一二年七月十三日 13 Jul 2012	0.027
二零一二年十月十一日 11 Oct 2012	0.031

表7. 二零一二年食物及環境樣本中之人工伽馬放射性核素的可測量伽馬活度測量結果

Table 7. Measurement results of measurable gamma activities of artificial gamma-emitting radionuclides in food and environmental samples in 2012

放射性核素: 銫-137 Radionuclide: Cs-137

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 (1) Activity (1)	BRMP 範圍 (2) BRMP range (2)	單位 Unit
牛鮸 *Platycephalus indicus* (Bartail flathead)	香港水域 Hong Kong Waters	1	-	0.04	≤ 0.2	Bq kg^{-1}
土壤(上層) Land soil (upper)	見表 1 See Table 1	4	0.8 – 1.6	1.2	≤ 10.0	Bq kg^{-1}
土壤(下層) Land soil (lower)	見表 1 See Table 1	5	0.6 – 1.3	1.0	≤ 4.0	Bq kg^{-1}
潮間帶土(上層) Intertidal sediment (upper)	白沙灣 Pak Sha Wan	4	0.2 – 0.4	0.3	≤ 2.4	Bq kg^{-1}
	尖鼻咀 Tsim Bei Tsui	4	0.6 – 0.8	0.7		
	沙頭角 Sha Tau Kok	4	0.4 – 0.7	0.6		
潮間帶土(下層) Intertidal sediment (lower)	白沙灣 Pak Sha Wan	4	0.2 – 0.3	0.3	≤ 3.1	Bq kg^{-1}
	尖鼻咀 Tsim Bei Tsui	4	0.6 – 0.8	0.7		
	沙頭角 Sha Tau Kok	4	0.5 – 0.8	0.6		
海床沉澱物 Seabed sediment	大灘海 Tai Tan Hoi	1	-	0.6	≤ 1.9	Bq kg^{-1}
	龍蝦灣 Lung Ha Wan	1	-	0.3		
	索罟灣 Picnic Bay	1	-	0.4		
	西區碇泊處 Western Anchorage	1	-	0.3		

註: (1) 如有多過一個樣本發現可測量活度，此欄則報告平均值。

(2) BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。

Note: (1) The mean activity is reported if there are more than one sample with measurable activities.

(2) BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as "≤ xx" where xx is the maximum measured activity value.

表 8. 二零一二年食物及環境樣本的可測量氚活度測量結果

Table 8. Measurement results of measurable activities of tritium in food and environmental samples in 2012

(每公斤貝可 Bq kg^{-1}; 每公升貝可 Bq L^{-1}; 每平方米貝可 Bq m^{-2}; 每立方米貝可 Bq m^{-3})

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度(1) Activity(1)	BRMP 範圍(2) BRMP range(2)	單位 Unit
食米 Rice	內地 Mainland	3	0.02 – 0.16	0.08	< 1	Bq kg^{-1}
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	2	0.7 – 0.9	0.8	< 6	Bq L^{-1}
	沙頭角 Sha Tau Kok	1	-	1.1		
菜心 Choi sum	深圳 Shenzhen	4	1.1 – 1.6	1.4	≤ 7.4	Bq kg^{-1}
	本地 Local	4	0.6 – 1.7	1.2		
白菜 Pak choi	深圳 Shenzhen	3	0.8 – 2.1	1.3	< 6	Bq kg^{-1}
	本地 Local	4	0.3 – 2.6	1.3		
荔枝 Lychee	內地 Mainland	1	-	0.8	< 4	Bq kg^{-1}
柑橘 Mandarin	內地 Mainland	2	0.9 – 1.3	1.1	< 4	Bq kg^{-1}
雞 Chicken	內地 Mainland	2	0.1 – 0.3	0.2	≤ 2.2	Bq kg^{-1}
	本地 Local	2	0.3 – 0.4	0.4		
鴨 Duck	內地 Mainland	1	-	0.3	≤ 3.5	Bq kg^{-1}
牛肉 Beef	內地 Mainland	2	0.9 – 1.1	1.0	≤ 5.3	Bq kg^{-1}
豬肝 Pig's liver	內地 Mainland	2	0.9 – 1.4	1.1	< 4	Bq kg^{-1}
	本地 Local	1	-	0.8		
豬肉 Pork	內地 Mainland	4	0.2 – 0.6	0.5	< 4	Bq kg^{-1}
	本地 Local	1	-	0.9		
大魚 *Aristichthys Nobilis* (Big-head carp)	深圳 Shenzhen	2	0.4 – 0.5	0.4	< 2	Bq kg^{-1}
	元朗 Yuen Long	3	0.4 – 0.8	0.6	< 2	Bq kg^{-1}
瓜三 *Nemipterus japonicus* (Melon coat)	香港水域 Hong Kong Waters	2	0.1 – 0.3	0.2	< 2	Bq kg^{-1}
牛鰍 *Platycephalus indicus* (Bartail flathead)	香港水域 Hong Kong Waters	3	0.1 – 0.6	0.4	< 2	Bq kg^{-1}
牙帶 *Trichiurus Haumela* (Hair tail)	香港水域 Hong Kong Waters	3	0.03 – 1.81	0.7	< 2	Bq kg^{-1}
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港水域 Hong Kong Waters	3	0.02 – 0.28	0.1	< 2	Bq kg^{-1}
	香港以西海域 Seas west of Hong Kong	1	-	0.1		
赤米蝦 *Metapenaeopsis Barbata* (Fire prawn)	香港水域 Hong Kong Waters	3	0.03 – 0.84	0.3	≤ 4.9	Bq kg^{-1}

表 8. (續)

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度[1] Activity[1]	BRMP 範圍[2] BRMP range[2]	單位 Unit
墨魚 *Sepia spp.* (Cuttlefish)	香港水域 Hong Kong Waters	3	0.7 – 1.6	1.1	≤ 2.7 [3]	Bq kg^{-1}
魷魚 *Loligo edulis* (Squid)	香港水域 Hong Kong Waters	3	0.4 – 1.9	0.9	< 3	Bq kg^{-1}
	香港以西海域 Seas west of Hong Kong	1	-	1.1		
東風螺 *Babylonia formosae* (Gastropod)	香港水域 Hong Kong Waters	2	0.4 – 0.9	0.7	< 1	Bq kg^{-1}
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau	1	-	0.5	< 2	Bq kg^{-1}
	吐露港 Tolo Harbour	2	0.4 – 0.5	0.4		
	大亞灣 Daya Bay	2	0.1 – 0.3	0.2		
蜆 *Tapes philippinarum* (Clam)	長洲 Cheung Chau	1	-	0.5	< 2	Bq kg^{-1}
	吐露港 Tolo Harbour	1	-	0.4		
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	1	-	0.4	< 2	Bq kg^{-1}
石蒓 *Ulva lactuca* (Sea lettuce)	布袋澳 Po Toi O	1	-	0.4	< 2	Bq kg^{-1}
濕沉積物 (降雨) Wet deposition (precipitation)	京士柏 King's Park	4	0.7 – 1.8	1.1	≤ 12	Bq L^{-1}
	沙頭角 Sha Tau Kok	5	0.1 – 3.4	1.3		
	元五墳 Yuen Ng Fan	2	0.5 – 1.0	0.7		
總沉積物 Total deposition	京士柏 King's Park	6	30 – 394	211	≤ 2210 [4]	Bq m^{-2}
大氣水蒸氣 Water vapour in air	京士柏 King's Park	4	0.01	0.01	≤ 242 [5]	Bq m^{-3}

表 8. (續)

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度[1] Activity[1]	BRMP 範圍[2] BRMP range[2]	單位 Unit
飲用水(經處理) Drinking water (treated)	九龍配水管 Kowloon distribution tap	2	1.1 – 1.5	1.3	< 6	Bq L^{-1}
	屯門配水管 Tuen Mun distribution tap	3	0.6 – 1.4	1.1		
	油柑頭濾水廠 Yau Kom Tau Treatment Works	2	0.4 – 1.9	1.1		
	屯門濾水廠 Tuen Mun Treatment Works	3	0.4 – 1.6	0.9		
	沙田濾水廠 Shatin Treatment Works	1	-	3.4		
飲用水 (未經處理) Drinking water (untreated)	木湖 B 抽水站 Muk Wu B Pumping Station	3	0.1 – 1.8	0.9	< 6	Bq L^{-1}
	油柑頭濾水廠 Yau Kom Tau Treatment Works	2	2.4– 2.9	2.7		
	屯門濾水廠 Tuen Mun Treatment Works	1	-	0.3		
	沙田濾水廠 Shatin Treatment Works	2	1.1 – 1.2	1.2		
	萬宜水庫 High Island Reservoir	3	0.4 – 4.4	2.3		
	船灣淡水湖 Plover Cove Reservoir	3	0.2 – 1.0	0.5		
地下水 Underground water	長康邨 Cheung Hong Estate	1	-	0.3	≤ 2.8	Bq L^{-1}
	鈞樂新村 Kwan Lok San Tsuen	1	-	0.3		
	環翠邨 Wan Tsui Estate	1	-	0.4		
	華富邨 Wah Fu Estate	1	-	0.4		
	富山邨 Fu Shan Estate	1	-	0.4		
	清涼法苑 Ching Leung Nunnery	1	-	0.4		

表 8. (續)

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度(1) Activity(1)	BRMP 範圍(2) BRMP range(2)	單位 Unit
海水(上層) Sea water (upper level)	火石洲 Basalt Island	1	-	1.0	< 6	Bq L^{-1}
樽裝水(蒸餾水) Bottled water (Distilled)	本地 Local	2	0.7 – 1.2	0.9	≤ 4.9 (6)	Bq L^{-1}
樽裝水(礦泉水) Bottled water (Mineral)	本地 Local	1	-	0.4	≤ 5.8 (6)	Bq L^{-1}

註: (1) 如有多過一個樣本發現可測量活度，此欄則報告平均值。
(2) BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。
(3) 該樣本測量始於一九九七年十月，並沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年的測量數值。
(4) 該樣本測量始於一九九六年一月，並沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年的測量數值。
(5) 現時測量的準確度相比 BRMP 時大幅提高，同時探測下限亦大幅下降，原因是在 2011 年採用了新的樣本前處理方法及在 2008 年應用了新的液體閃爍計數系統作測量。
(6) 該樣本測量始於二零零七年五月，並沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年的測量數值。

Note: (1) The mean activity is reported if there is more than one sample with measurable activities.
(2) BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as "≤ xx" where xx is the maximum measured activity value.
(3) Measurement of this sample started in October 1997. The sample was not measured in BRMP. The indicated range refers to results from first 5 years' sample measurement.
(4) Measurement of this sample started in January 1996. The sample was not measured in BRMP. The indicated range refers to results from first 5 years' sample measurement.
(5) Substantially higher accuracy and lower detection limit are achieved for current measurement when compared to those of the BRMP owing to the adoption of a new sample pre-treatment method in 2011 and the implementation of a new Liquid Scintillation Counting System for measurement in 2008.
(6) Measurement of this sample started in May 2007. The sample was not measured in BRMP. The indicated range refers to results from first 5 years' sample measurement.

表 9. 二零一二年食物及環境樣本的可測量鍶-90 活度測量結果

Table 9. Measurement results of measurable activities of strontium-90 in food and environmental samples in 2012

(每公斤貝可 Bq kg^{-1}；每公升貝可 Bq L^{-1}；每立方米貝可 Bq m^{-3}；每平方米貝可 Bq m^{-2}；每公斤毫貝可 mBq kg^{-1}；每公升毫貝可 mBq L^{-1}；每立方米微貝可μBq m^{-3})

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度(1) Activity(1)	BRMP 範圍(2) BRMP range(2)	單位 Unit
食米 Rice	內地 Mainland	3	5 – 9	7	≤ 56	mBq kg^{-1}
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	4	8 – 11	9	≤ 81	mBq L^{-1}
	沙頭角 Sha Tau Kok	4	6 – 7	7		
菜心 Choi sum	深圳 Shenzhen	4	21 – 103	63	≤ 266	mBq kg^{-1}
	本地 Local	4	20 – 53	34		
白菜 Pak choi	深圳 Shenzhen	4	14 – 134	73	≤ 570	mBq kg^{-1}
	本地 Local	4	43 – 100	63		
香蕉 Banana	內地 Mainland	3	3 – 7	5	≤ 27	mBq kg^{-1}
荔枝 Lychee	內地 Mainland	1	-	3	≤ 14	mBq kg^{-1}
柑橘 Mandarin	內地 Mainland	2	6 – 6	6	≤ 84	mBq kg^{-1}
雞 Chicken	內地 Mainland	4	2 – 4	3	≤ 37	mBq kg^{-1}
	本地 Local	2	2 – 2	2		
鴨 Duck	內地 Mainland	1	-	4	≤ 53	mBq kg^{-1}
牛肉 Beef	內地 Mainland	1	-	10	≤ 35	mBq kg^{-1}
大魚 *Aristichthys nobilis* (Big-head carp)	深圳 Shenzhen	3	7 – 16	11	≤ 94	mBq kg^{-1}
	元朗 Yuen Long	3	4 – 8	6		
瓜三 *Nemipterus japonicus* (Melon coat)	香港水域 Hong Kong Waters	1	-	4	≤ 21	mBq kg^{-1}
牛鰍 *Platycephalus indicus* (Bartail flathead)	香港水域 Hong Kong Waters	2	5 – 7	6	≤ 25	mBq kg^{-1}
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港水域 Hong Kong Waters	1	-	6	≤ 105	mBq kg^{-1}
赤米蝦 *Metapenaeopsis barbata* (Fire prawn)	香港水域 Hong Kong Waters	1	-	9	≤ 66	mBq kg^{-1}
墨魚 *Sepia spp* (Cuttlefish)	香港水域 Hong Kong Waters	1	-	11	≤ 24 (3)	mBq kg^{-1}
魷魚 *Loligo edulis* (Squid)	香港水域 Hong Kong Waters	2	13 – 16	14	≤ 43	mBq kg^{-1}
東風螺 *Babylonia formosae* (Gastropod)	香港水域 Hong Kong Waters	1	-	4	≤ 31	mBq kg^{-1}
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau	2	8 – 9	8	≤ 47	mBq kg^{-1}
	吐露港 Tolo Harbour	1	-	19		
	大亞灣 Daya Bay	2	4 – 8	6		

表 9. (續)

Table 9. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度[1] Activity[1]	BRMP 範圍[2] BRMP range[2]	單位 Unit
蜆 *Tapes philippinarum* (Clam)	長洲 Cheung Chau	1	-	30	≤ 32	mBq kg^{-1}
	吐露港 Tolo Harbour	1	-	26		
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	1	-	150	≤ 1440	mBq kg^{-1}
澁苔 *Enteromorpha prolifera* (Sea hair)	吐露港 Tolo Harbour	1	-	29	< 100	mBq kg^{-1}
大氣飄塵 Airborne particulate	京士柏 King's Park	7	1.3 – 3.1	2.0	≤ 5	μBq m^{-3}
	沙頭角 Sha Tau Kok	8	1.4 – 4.5	3.0		
	元五墳 Yuen Ng Fan	8	1.0 – 4.9	3.5		
濕沉積物(降雨) Wet deposition (precipitation)	京士柏 King's Park	2	7.2 – 8.6	7.9	≤ 39	mBq L^{-1}
	沙頭角 Sha Tau Kok	6	3.0 – 8.0	5.4		
	元五墳 Yuen Ng Fan	5	3.7 – 12.2	6.2		
總沉積物 Total deposition	京士柏 King's Park	5	0.7 – 1.6	1.2	≤ 3.9 [4]	Bq m^{-2}
土壤(上層) Land soil (upper)	見表 1. Please see Table 1.	8	10.1 – 26.2	20.7	≤ 27.3	Bq kg^{-1}
土壤(下層) Land soil (lower)	見表 1. Please see Table 1.	7	1.6 – 19.7	11.6	≤ 19.9	Bq kg^{-1}
海水中懸浮粒子(上層) Suspended particulate in sea water (upper level)	大浪灣 Tai Long Wan	1	-	3.1	< 7	mBq L^{-1}
	赤洲 Port Island	1	-	3.6		
海水中懸浮粒子(中層) Suspended particulate in sea water (middle level)	大浪灣 Tai Long Wan	1	-	2.7	< 7	mBq L^{-1}
	橫瀾島 Waglan Island	1	-	2.5		

註: (1) 如有多過一個樣本發現可測量活度，此欄則報告平均值。

(2) BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。

(3) 該樣本測量始於一九九七年十月，並沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年的測量數值。

(4) 該樣本測量始於一九九六年一月，並沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年的測量數值。

Note: (1) The mean activity is reported if there is more than one sample with measurable activities.

(2) BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as "≤ xx" where xx is the maximum measured activity value.

(3) Measurement of this sample started in October 1997. The sample was not measured in BRMP. The indicated range refers to results from first 5 years' sample measurement.

(4) Measurement of this sample started in January 1996. The sample was not measured in BRMP. The indicated range refers to results from first 5 years' sample measurement.

表10. 二零一二年食物及環境樣本的可測量鈈-239活度測量結果

Table 10. Measurement results of measurable activities of plutonium-239 in food and environmental samples in 2012

類別 Type	**地點 Location**	**含有可測量活度的樣本總數 Total no. of samples with measurable activity**	**範圍 Range**	**活度[(1)] Activity[(1)]**	**BRMP 範圍[(2)] BRMP range[(2)]**	**單位 Unit** 每公斤貝可 Bq kg^{-1}
潮間帶土(上層) Intertidal sediment (upper)	沙頭角 Sha Tau Kok	1	-	0.17	≤ 0.19	Bq kg^{-1}
	尖鼻咀 Tsim Bei Tsui	2	0.12 – 0.18	0.15		
海床沉澱物 Seabed sediment	索罟灣 Picnic Bay	1	-	0.22	≤ 0.57	Bq kg^{-1}
	大灘海 Tai Tan Hoi	1	-	0.53		
	龍蝦灣 Lung Ha Wan	1	-	0.46		

註:

(1) 如有多過一個樣本發現可測量活度，此欄則報告平均值。

(2) BRMP 測量結果低於探測下限以“< xx”表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲“≤ xx”，xx 則爲測量到的活度最大值。

Note:

(1) The mean activity is reported if there is more than one sample with measurable activities.

(2) BRMP results that are below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as “≤ xx” where xx is the maximum measured activity value.

表 11. 二零一二年樣本整體測量結果概要

Table 11. Overall summary of measurement results of samples in 2012

(每公斤貝可 Bq kg^{-1}; 每公升貝可 Bq L^{-1}; 每立方米微貝可μBq m^{-3})

途徑 Pathway	樣本類別 Sample Type	測量結果(1) Measurement results(1) / 參考數值(1) Reference values(1)	碘-131 I-131	銫-137 Cs-137	銫-134 Cs-134	氚 H-3	鍶-90 Sr-90	鈈-239 Pu-239	單位 Unit
大氣 Atmospheric	大氣飄塵 (每月累積樣本) Airborne Particulate (bulked monthly sample)	範圍 Range	**< 10**	**< 10**	**< 10**	---(2)	**1.0 | 4.9**	**< 0.2**	μBq m^{-3}
		BRMP	< 10(3)	< 10	< 10		≤ 5	< 0.2	
地面Terrestrial	食米 Rice	範圍 Range	**< 0.2**(4)	**< 0.2**	**< 0.1**	**0.02 | 0.16**	**0.005 | 0.009**	---	Bq kg^{-1}
		BRMP	< 0.1	≤ 0.9	< 0.1	< 1	≤ 0.056		
	牛奶 Milk	範圍 Range	**< 0.2**	**< 0.3**	**< 0.3**	**0.7 | 1.1**	**0.006 | 0.011**	---	Bq L^{-1}
		BRMP	< 0.2	≤ 0.3	< 0.3	< 6	≤ 0.081		
	蔬菜Vegetable	範圍 Range	**< 0.3**	**< 0.4**	**< 0.3**	**0.3 | 2.6**	**0.014 | 0.134**	---	Bq kg^{-1}
		BRMP	< 0.3	< 0.4	< 0.3	≤ 7.4	≤ 0.570		
水 Aquatic	魚 Fish	範圍 Range	**< 0.1**	**0.04**	**< 0.1**	**0.03 | 1.81**	**0.004 | 0.016**	**< 0.002**	Bq kg^{-1}
		BRMP	< 0.1	≤ 0.2	< 0.1	< 2	≤ 0.094	< 0.002	
	經處理的飲用水 Treated Drinking Water	範圍 Range	**< 0.1**	**< 0.1**	**< 0.1**	**0.4 | 3.4**	---	---	Bq L^{-1}
		BRMP	< 0.1	< 0.1	< 0.1	< 6			

註:

(1) 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，BRMP 結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。

(2) --- 表示沒有在 BRMP 及 ERMP 進行此項測量。

(3) 在 BRMP 期間分析的大氣飄塵樣本中，只有京士柏兩個樣本測量出碘-131，活度分別是 328 μBq m^{-3} 及 38 μBq m^{-3}，但經調查後相信碘-131 是來自附近伊利沙伯醫院的小量低放射性醫療廢物排放，因此並不應將這些樣本在 BRMP 期間測量出的碘-131 活度視爲大氣飄塵的本底活度範圍。大氣飄塵的 BRMP 碘-131 本底範圍應爲低於探測下限。

(4) 2012 年食米樣本碘-131 的探測下限值相比 BRMP 期間的略高，原因可能是 2012 年的實際測量情況跟 BRMP 時的典型測量情況有些微差異及數字進位所致。

Notes:

(1) Results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the BRMP results will be reported as "≤ xx" where xx is the maximum measured activity value.

(2) --- means "Measurements not included under BRMP and ERMP".

(3) During the BRMP period, among the airborne particulate samples analysed, I-131 was detected only in two weekly samples at King's Park (activity 328 μBqm^{-3} and 38 μBq m^{-3}), subsequent investigation suggested that a possible source of I-131 could be the release of small amount of low-level radioactive medical waste from Queen Elizabeth Hospital nearby. Hence the I-131 activities detected in these samples during BRMP should not be interpreted as baseline activity for airborne particulate. The baseline BRMP range of I-131 in airborne particulate should be below MDA.

(4) The reason for the slight increase in MDA for I-131 measurement of rice samples in 2012 as compared with that of BRMP is likely due to minor variations of the actual measurement conditions in 2012 as compared to the typical measurement conditions in BRMP and rounding of figures.

表 12. 二零一二年中國輻射防護研究院安排的戶外環境伽馬劑量率測量比對結果

Table 12. Results of the 2012 inter-comparison exercise on ambient gamma dose rate measurement, organised by the China Institute for Radiation Protection (CIRP)

比對日期及地點 Date and Location of Inter-laboratory Comparison	**測量點 Survey Point**	**天文台測量結果 Measurement Result of the Hong Kong Observatory ($nGy\ h^{-1}$)**	**偏差[(1)] Deviation[(1)] (%)**
八月二十三至二十七日 23 to 27 August 黑龍江省漠河縣政府辦公大樓東側廣場 Open area to the east of Government Office Building, Mohe, Heilongjiang	1	99.9	+2.1
	2	99.4	+0.6
	3	103	+2.0
	4	96.5	+0.6
	5	105	+4.0
	6	102	+1.0
十一月十五至十八日 15 to 18 November 香港京士柏氣象站 King's Park Meteorological Station, Hong Kong	A	185	+9.5
	B	179	+9.1
	C	178	+10.6
	D	180	+11.1
	E	182	+9.6

註:
(1) 偏差 = (測量值 — 參考值) / 參考值 x 100% ，參考值爲所有參與單位的測量平均值。

Note:
(1) Deviation = (Measured value – Reference value)/Reference value x 100%. Reference value is the mean measured value of all participants.