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Towards a Water Sensitive City: The role of Water Governance

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Προς μια πόλη με επίκεντρο το νερό: Ο ρόλος της διακυβέρνησης των υδάτων

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Abstract

There is a growing debate about the environmental, social and economic pressures that many places in the world unevenly face. The vast majority of pressures are inherently connected to the water resources, jeopardizing the meet of current and future human needs, in every domain of human activity, making, at the same time, apparent the need for paradigm shift.

The aim of the thesis, which has been conducted by literature's critical search and review, is the exploration of the contribution of water governance schemes in the sustainable and holistic water management, with special regard to urban areas, since it is widely accepted that water governance is of crucial importance for sustainability of ecosystems and water security and sensitivity.

Current global pressures and the water management traditional and emerging tendencies and challenges are discussed. Furthermore, the role, the dominant and new forms of governance and water governance are investigated, together with the water governance bottlenecks and principles on good governance. Finally, the approaches proposed in order to move to more sustainable, integrated and water sensitive cities are discussed. The main conclusions and proposals for further research are presented in the final chapter of the thesis.

Εκτενής Περίληψη

Οι σύγχρονες περιβαλλοντικές, κοινωνικές και οικονομικές συνθήκες προκαλούν πρωτοφανείς και άνισα κατανεμημένες προκλήσεις σε παγκόσμιο επίπεδο, η πλειονότητα των οποίων είναι άρρηκτα συνδεδεμένη με τους υδατικούς πόρους, υπονομεύοντας την κοινωνική και οικονομική ευημερία του παρόντος και του μέλλοντος και δημιουργώντας αδήριτη ανάγκη για βελτίωση των πρακτικών διαχείρισης των υδάτων.

Στόχο της εργασίας, η οποία είναι αποτέλεσμα κριτικής βιβλιογραφικής έρευνας και ανασκόπησης, αποτελεί η διερεύνηση του ρόλου της διακυβέρνησης των υδάτων στην επίτευξη βιώσιμων και ολοκληρωμένων στρατηγικών διαχείρισης των υδατικών πόρων, με ιδιαίτερη μνεία στην ανάπτυξη ολιστικού, συντονισμένου και μακροπρόθεσμου σχεδιασμού, ο οποίος λαμβάνει υπόψη του τον κύκλο του νερού και την αλληλεπίδραση του με άλλους τομείς της ανθρώπινης δραστηριότητας, όπως η γεωργία, η βιομηχανία, η πολεοδομία, οι μεταφορές, η ενέργεια και άλλες, στις αστικές περιοχές.

Αρχικά, δίνεται το περίγραμμα των παγκόσμιων προβλημάτων σχετικών με τους υδατικούς πόρους και αναλύονται οι παραδοσιακοί και σύγχρονοι τρόποι διαχείρισης των υδάτων, καθώς και οι δυσκολίες οι οποίες τους χαρακτηρίζουν. Στη συνέχεια, γίνεται προσπάθεια εμβάθυνσης στις επικρατούσες και νέες μορφές διακυβέρνησης του νερού, διερευνώνται τα πλεονεκτήματα, μειονεκτήματα και δυσκολίες εφαρμογής των πρακτικών διακυβέρνησης σε κάθε περίπτωση, ενώ εξετάζονται οι βασικές κατευθυντήριες αρχές χρηστής διακυβέρνησης. Ακολουθεί η μελέτη προσεγγίσεων που έχουν προταθεί προκειμένου να επιτευχθεί υψηλότερος βαθμός βιωσιμότητας και ευαισθησίας στο νερό στον αστικό σχεδιασμό. Τέλος, παρατίθενται συμπεράσματα και προτάσεις για περαιτέρω διερεύνηση.

Αν και η αξία των υδατικών πόρων για την ανθρώπινη ζωή και ευημερία είναι πολύτιμη, αδιαμφισβήτητη και αυταπόδεικτη, η έννοια του νερού ως αγαθού ποικίλει. Παραδείγματος χάριν, το νερό θεωρείται δημόσιο αγαθό, οικονομικό και κοινωνικό αγαθό, ιερή οντότητα ή και πολιτιστική κληρονομιά, στοιχείο οικοσυστημάτων ή και γεωπολιτικός φυσικός πόρος. Σε κάθε περιοχή της γης, αναλόγως με τις επικρατούσες κοινωνικές, πολιτιστικές, ιστορικές, πολιτικές, οικονομικές, γεωγραφικές και υδρολογικές συνθήκες, διαφορετικές πτυχές της πολυσχιδούς φύσης των υδατικών πόρων προτάσσονται ως πρωταρχικές, δημιουργώντας συνθήκες διαβούλευσης - αντιπαράθεσης μεταξύ των ενδιαφερόμενων μερών, προκειμένου να καθοριστεί ο βέλτιστος - σύμφωνα με την έκαστη οπτική γωνία - τρόπος διαχείρισης των υδάτων.

Η υποβάθμιση του περιβάλλοντος και η κλιματική αλλαγή, θέματα που προκαλούν μείζονα ανησυχία σε παγκόσμιο επίπεδο, είναι αναπόσπαστα συνδεδεμένα με τους υδατικούς πόρους. Ακραία καιρικά φαινόμενα, όπως ασυνήθιστες θερμοκρασίες, έντονες βροχοπτώσεις και πλημμύρες, παρατεταμένη ξηρασία, σε συνδυασμό με το αποτύπωμα της ανθρώπινης δραστηριότητας στο περιβάλλον, επιδεινώνουν την ποιοτική και ποσοτική κατάσταση των υδάτων παγκοσμίως, δημιουργώντας έναν φαύλο κύκλο και τη λεγόμενη κρίση των υδάτων. Η κρίση στα ύδατα, σχετίζεται περισσότερο με την άνιση κατανομή του νερού στα διάφορα μέρη του πλανήτη, καθώς και με την συνήθη έλλειψη ισοζυγίου μεταξύ της ζήτησης και της προσφοράς. Η εμφάνιση μιας κρίσης εκτός από αιτία, μπορεί να θεωρηθεί και ως μια ευκαιρία επανεξέτασης των ζητημάτων και να παρακινήσει σε ευαισθητοποίηση και αλλαγή. Τα μέτρα αντιμετώπισης ενός προβλήματος μπορεί να είναι προληπτικά ή αντίδρασης. Όπως είναι λογικό, τα μέτρα αντίδρασης μπορεί να αποδειχθούν μειωμένης αποτελεσματικότητας και αυξημένου κόστους, σε αντίθεση με τα προληπτικά μέτρα, καταδεικνύοντας ακόμη μια φορά τη σημασία του ορθού σχεδιασμού διαχειριστικών μέτρων.

Για την ανάλυση ενός φαινομένου, κρίσιμο σημείο είναι η επιλογή κατάλληλης κλίμακας και αφετηρίας. Στη συγκεκριμένη περίπτωση, δίνεται ιδιαίτερη έμφαση στις αστικές περιοχές, με δεδομένο ότι οι πόλεις κατά κανόνα αποτελούν τον πυρήνα της κοινωνικής, οικονομικής, τεχνολογικής, πολιτιστικής ανάπτυξης και καινοτομίας, μπορούν να θεωρηθούν ως κομβικά σημεία παραγωγής και κατανάλωσης αγαθών και παραγωγής αποβλήτων, ενώ απορροφούν όλο και μεγαλύτερα ποσοστά πληθυσμού. Κατά συνέπεια, εκτός από τις κλιματικές μεταβολές και τις αυξημένες συνέπειες της αστικοποίησης, άλλοι συσχετισμένοι παράγοντες επιβάρυνσης του νερού που μπορεί να εμφανιστούν στις αστικές περιοχές είναι η ρύπανση, η λειψυδρία, η αλάτωση, η διάβρωση, ο ανταγωνισμός μεταξύ οικιακής, βιομηχανικής και γεωργικής χρήσης, η γήρανση, η κακή συντήρηση ή η μη υπάρχουσα υποδομή, φαινόμενα που υπονομεύουν τη σταθερότητα και αποδεικνύουν πόσο ξεπερασμένες και ανεπαρκείς για τις μελλοντικές ανάγκες είναι κάποιες από τις πρακτικές που ακολουθώνται σήμερα από τους εμπλεκόμενους φορείς.

Η ιστορία διαχείρισης των υδάτων σχεδόν ταυτίζεται με την ανθρώπινη ιστορία, καθώς από τα αρχαία χρόνια υπήρχε η ανάγκη χρηστής διαχείρισης και διανομής του νερού, προκειμένου να διασφαλιστεί η αυτάρκεια και επιβίωση των κοινωνιών.

Η διαχείριση των υδάτων είναι ένα πολύπλοκο σύνολο πρακτικών και διαδικασιών λήψης αποφάσεων, προκειμένου να διασφαλιστεί ότι η αλληλεπίδραση μεταξύ ανθρώπου και περιβάλλοντος παρέχει την προστασία, τη συντήρηση και την ενίσχυση των λειτουργιών και των οφελών του κύκλου του ύδατος, όπως η διασφάλιση της δημόσιας υγείας, η δίκαιη κατανομή ύδατος, η προστασία από κινδύνους σχετικούς με το νερό, η οικονομική ανάπτυξη, η αναψυχή και άλλων.

Στη σημερινή εποχή, ο παραδοσιακός προσανατολισμός της διαχείρισης των υδάτων έδινε- και δίνει, σε κάποιες περιπτώσεις- μονοδιάστατη έμφαση στη βελτιστοποίηση ορισμένων πτυχών του κύκλου των υδάτων, αγνοώντας τους άλλους, με κύριο στόχο τη μεγιστοποίηση της ανάπτυξης, χρησιμοποιώντας υψηλής τεχνολογίας μέσα. Απότοκα αυτής της προσέγγισης είναι ο θεσμικός κατακερματισμός και η έλλειψη συντονισμού στο σχεδιασμό και τη λειτουργία των σχετικών υποδομών ύδρευσης και αποχέτευσης, οι οποίες, μεταξύ άλλων συνήθως είναι ενεργοβόρες, χωρίς ιδιαίτερη πρόβλεψη για αποκατάσταση των πόρων, βιώσιμη αστική διαχείριση και επεξεργασία στην πηγή.

Η γενικότερη συνειδητοποίηση της σημασίας και των επιπτώσεων της περιβαλλοντικής υποβάθμισης και των πιέσεων που αναφέρθηκαν παραπάνω, επέφερε ρεύμα αλλαγής της επικρατούσας νοοτροπίας, η οποία εξελισσόμενη, προσπαθεί να λαμβάνει υπόψη τους σημαντικότερους τομείς που σχετίζονται με το νερό. Ως εκ τούτου, τα τελευταία χρόνια, η διαχείριση των υδάτων αποτελεί μέσο για την επίτευξη ασφάλειας, δικαιοσύνης και βιωσιμότητας στη χρήση των υδάτων, σε μια προσπάθεια άμβλυνσης των αβεβαιοτήτων που σχετίζονται με τους υδατικούς πόρους.

Παράμετρος με βαρύνουσα σημασία στην διαχείριση των υδάτων (water management) είναι η διακυβέρνηση των υδάτων (water governance). Η διακυβέρνηση των υδάτων, αποτελεί κατά κύριο λόγο υποσύνολο της διακυβέρνησης ενός κράτους (governance) και για το λόγο αυτό η διερεύνηση του ρόλου της διακυβέρνησης των υδάτων, στην παρούσα εργασία, ξεκινά από τη διερεύνηση της γενικότερης έννοιας της διακυβέρνησης.

Η δομή της διακυβέρνησης έχει δυναμικό χαρακτήρα, δεδομένου ότι αλλάζει χρονικά και χωρικά και μπορεί να έχει πολλές διαφορετικές μορφές ανάλογα με το διαφορετικό πολιτιστικό, ιστορικό, γεωγραφικό, πολιτικό, νομικό και διοικητικό υπόβαθρο, καθώς και τις κλιματικές και οικονομικές, κοινωνικές και άλλες συνθήκες που επικρατούν σε κάθε μέρος του κόσμου. Επομένως, διαφορετικοί πολιτισμοί αναπτύσσουν διαφορετικά συστήματα διακυβέρνησης, γεγονός που επηρεάζει επακόλουθα και τη διακυβέρνηση των υδάτων, δημιουργώντας σχετική εννοιολογική ασάφεια.

Τυπικές ιδεατές μορφές διακυβέρνησης είναι η ιεραρχική (hierarchical governance), η διακυβέρνηση δικτύου (network governance) και η διακυβέρνηση ενιαίας αγοράς (market governance). Ωστόσο, οι σύγχρονες συνθήκες, σε συνδυασμό με φαινόμενα αναποτελεσματικότητας και ανεπάρκειας των υπαρχουσών δομών διακυβέρνησης, έχουν ωθήσει στην ανάπτυξη νέων μορφών διακυβέρνησης, μεταξύ των οποίων συγκαταλέγονται η πολυκεντρική διακυβέρνηση (polycentric governance), η προσαρμοστική διακυβέρνηση (adaptive governance) και η πολυεπίπεδη διακυβέρνηση (multi-level governance). Κοινό χαρακτηριστικό των συστημάτων

διακυβέρνησης είναι η προσπάθεια εξισορρόπησης εξουσίας και προτεραιοτήτων, δεδομένου ότι η διακυβέρνηση είναι ο κεντρικός υπεύθυνος λήψης αποφάσεων στην κοινωνία, λαμβάνοντας υπόψη εξωτερικές και εσωτερικές δυνάμεις και πιέσεις.

Η πολύπλοκη και πολυπαραγοντική φύση της διακυβέρνηση των υδάτων, έχει ως αποτέλεσμα εννοιολογική, ερμηνευτική, μορφολογική και λειτουργική πολυμορφία. Αν και δεν υπάρχει καθολικώς αποδεκτός ορισμός της έννοιας αυτής, η διακυβέρνηση των υδάτων θα μπορούσε να οριστεί ως σειρά διαδικασιών που βασίζονται σε μεθόδους λήψης αποφάσεων μεταξύ διαφορετικών επιπέδων και διάφορων τομέων, ενδιαφερομένων και αρχών, προοπτικών και συμφερόντων, έτσι ώστε να καθιερωθεί η στρατηγική διαχείρισης των υδάτων, για την επίλυση των προβλημάτων που σχετίζονται με το νερό.

Οι υφιστάμενες προκλήσεις και αποτυχίες που αντιμετωπίζει η σύγχρονη διακυβέρνηση των υδάτων σε πολλά μέρη του κόσμου, οι οποίες προκαλούν επίσης δυσαρέσκεια, δυσλειτουργία και ανάγκη αλλαγής στρατηγικής, περιλαμβάνουν συνήθως νομικά, νομοθετικά, οικονομικά, πολιτικά και διοικητικά θέματα, τα οποία πολλές φορές είναι αλληλένδετα και αλληλεξαρτώμενα, καθιστώντας την πορεία προς την υιοθέτηση πολιτικών χρηστής διακυβέρνησης αναγκαία.

Για την αντιμετώπιση των προκλήσεων αυτών, έχουν προταθεί πολλά πλαίσια δράσης, είτε από επίσημους κυβερνητικούς φορείς, σε επίπεδο νομοθεσίας, όπως είναι η Οδηγία-Πλαίσιο για τα Ύδατα, της Ε.Ε., είτε από μη κυβερνητικές οργανώσεις παγκοσμίως, τα οποία παρουσιάζονται και αναλύονται.

Ανάμεσα στα προτεινόμενα πλαίσια διαχείρισης που έχουν αναπτυχθεί και εφαρμόζονται ή γίνεται προσπάθεια να υιοθετηθούν σε διάφορες περιοχές του κόσμου, προκειμένου να ενισχυθεί η βιωσιμότητα, η ευελιξία και η ανθεκτικότητα των κοινωνιών σε θέματα σχετικά με τους υδατικούς πόρους είναι τα εξής: ''Ολοκληρωμένη Διαχείριση Των Υδατικών Πόρων'' (Integrated Water Resources Management), ''Βιώσιμη Διαχείριση Αστικών Υδάτων'' (Sustainable Urban Water Management), ''Αστικός Σχεδιασμός Ευαίσθητος Στο Νερό'' (Water Sensitive Urban Design), ''Πόλη Ευαίσθητη Στο Νερό'' (Water Sensitive City). Το κάθε πλαίσιο παρέχει, σε διαφορετικό βαθμό, κατευθυντήριες αρχές και πρόγραμμα δράσης, αν και τα όρια μεταξύ των διαφορετικών προσεγγίσεων δεν είναι πάντα ευδιάκριτα.

Αν και η απαίτηση για βελτίωση των πολιτικών διαχείρισης και διακυβέρνησης των υδατικών πόρων είναι αδιαμφισβήτητη, πρέπει να τονιστεί ότι δεν υπάρχει μια και μοναδική ή ιδανική λύση αρμόζουσα σε κάθε περίπτωση και περιοχή. Αντιθέτως, πρέπει να γίνεται επισταμένη και εμπεριστατωμένη έρευνα, που να λαμβάνει υπόψη το ολικό υπόβαθρο κάθε συγκεκριμένης περίπτωσης, έτσι ώστε να αναπτυχθεί μοντέλο δράσης που να εξυπηρετεί τις δεδομένες ανάγκες, αξιοποιώντας ταυτόχρονα την υπάρχουσα υποδομή.

Ως μελλοντική εργασία προτείνεται η διερεύνηση της εθνικής και τοπικής διαχείρισης και διακυβέρνησης των υδάτινων πόρων στην Ελλάδα, προκειμένου να προσδιοριστούν οι τρέχουσες δυσκολίες, η υφιστάμενη πολιτική και νομοθεσία, οι περιορισμοί και τα οφέλη, καθώς και οι ευκαιρίες, προκειμένου να επιτευχθεί υψηλότερος βαθμός ευαισθησίας και βιωσιμότητας στη διαχείριση του νερού.

Extended abstract

In the modern world, environmental, social and economic conditions have triggered unparalleled and unevenly allocated challenges. The vast majority of pressures are inherently connected to the water resources, jeopardizing the meet of current and future human needs, in every domain of human activity, making, at the same time, apparent the need for paradigm shift.

The aim of the thesis, which has been conducted by literature's critical search and review, is the exploration of the contribution of water governance schemes in the sustainable and holistic water management, with special regard to urban areas, since it is widely accepted that water governance is of crucial importance for sustainability of ecosystems and water security and sensitivity. This can be confirmed by the common assertion that the water crisis that many countries in the world confronts is more a governance crisis (World Water Council, 2003)

To begin with, current global pressures and the water management traditional and emerging tendencies and challenges are discussed. Furthermore, the role, the dominant and new forms of governance and water governance are investigated, together with the water governance bottlenecks and principles on good governance. Finally, the approaches proposed in order to move to more sustainable, integrated and water sensitive cities are discussed. The main conclusions and proposals for further research are presented in the final chapter of the thesis.

Even though water is sine qua non condition of human life and well-being, the notion about water diversify from people to people. For example, water is perceived, inter alia, as a public, social, economic or political good, as a geopolitical resource, as a sacred commodity, as a heritage, as a hydrological entity. As a result, different actors in the water ''system'' give priority to other aspects and that generates dialogue-competition among them, in order to define the most suitable ways of managing water resources. (Gupta & Pahl-Wostl, 2013)

Environmental downgrading and climate change, which are among the most looming international concerns in the last decades, are inextricably linked to water resources. Generally speaking, there is a loop-vicious circle, where climate change, which leads to more extreme and recurring weather events and human activity deteriorate the water quality and quantity, globally. This has brought about the introduction of the term ''water crisis'', which is basically related not to complete shortage of water, but to phenomena such as injustice in water sharing and imbalance between water supply and demand (Butterworth, 2010). Water crises have been manifested in variant forms and scales in many places in the world and their importance has

diverse meaning for different people and parts of society (Olsson, 2015). It is probable that a crisis can motivate change (Olsson, 2015) and raise awareness.

One of the most critical questions in the environmental and especially water-associated matters is the appropriate scale for the analysis, as well as the starting point of it. For the vast majority of the countries in the world, the starting point for almost every kind of activity is urban areas. Cities are the core of social, economic, tecnological, cultural growth and innovation (OECD, 2015), population absorbers or even midpoints of production, consumption and waste (Koop & Van Leeuwen, 2016). Except climate change and increased urbanization's concequences, other water related sectors present in urban regions- pollution, scarcity, salinazation, erosion, competition among domestic, industrial and agricultural users, ageing, poor maintained or non existant infrastructure- threaten smooth operetion and stability and also demonstrate how outdated and unsufficient for the future current practices are. (OECD, 2015; Koop & Van Leeuwen, 2016).

Given the preciousness of water for life prosperity, water management history is presumably as ancient as human history.

Water management can be defined as a complex set of practices and processes, in order to be ensured that human-environment interaction provides the protection, maintenance and enhancement of water cycle operations and benefits, such as public health, supply and risks security, economic development, equity, recreation.

In the modern world, traditional water management was single-sector oriented, with problem-solving approach and main objective the maximization of development, using technological state-of-the-art means (Hooper, 2003; Wong & Brown, 2009; Ashley et al., 2013), without special provision for resource rehabilitation or urban livability.

After the movement for the environment in 1970's, this conversional management perspective has been questioned (Hooper, 2003), since it had become evident that the reciprocal influence between water sector and other crucial areas, as urban planning, energy sector, transportation systems, production sector, agriculture is very strong and important to be ignored anymore. Recently, internationally, water management is a means to accomplish water security, fairness and sustainability in water use, so as to soothe water risks

A vital factor in water management's conceptualization and implementation is the water governance. As it is logically inferred, water governance is a part of governance in general. In light of this, the first step in order to study water governance is to better analyze the term governance.

There is no a clear-cut answer in the question what is governance, even though there is an almost blanket acceptance of its importance. This is partly due to the

dissimilar political and academic background, which generates conceptual vagueness and different perception and practices of governance. (Castro, 2007).

Governance structure has a dynamic nature, since it changes in time and space, and it may have many different forms depending on the diverse cultural, historical, geographic, political, legal and administrative background, along with the climatic and economic conditions and social and other circumstances. (OECD, 2018; Rogers & Hall, 2003). As a result, different governance schemes are produced by different cultures. (Castro, 2007).

There is no one and only acceptable definition of the term governance globally. Generally speaking, governance expresses the systems of organization of a society, on the grounds that it delineates who does what on the basis of acceptable institutional norms and behaviors and it is mostly the product of the activities of governments and various other actors, including institutional authorities and regulators, service providers, business and industry, scientists, researchers and academia, civil society, customer associations, trade unions and workers, international organizations, pressure groups, advisors and media (OECD, 2015 A).

In the literature, in an attempt of deeper understanding of governance concept, there are three primary institutional forms of external governance: hierarchical, network and market, the ideal features of which are described. However, the conventional political reality is changing in the last two decades and, in combination with many social and economic changes have enabled the procedure of governance transformation. (Rogers & Hall, 2003; http://iog.ca/what-is-governance/). Current novelties added in traditional types of political practice are market-based and voluntary structures, with the participation of state and not state actors (such as society, private sector) and a certain extent of self-regulation and coalitions (Olsson & Head, 2015) and among the emerging forms of governance are the adaptive, polycentric and multilevel governance.

A common feature in governance systems is the effort to balance power and priorities, since governance is the central decision maker in the society, taking into account external and internal forces and pressures, such as public preferences and ambitions, international agreements and treaties, short-term political expediencies, decentralization, donor priorities etc. (Bakker & Morinville, 2013).

There is no internationally agreed definition for water governance, due to the fact that its pluralistic and complex nature makes that difficult. It can be claimed that water governance is a suite of procedures based on decision making methods among different levels and various sectors, stakeholders and authorities, perspectives and interests, so as to establish water management, for resolving water related issues (Hooper B., 2006; Koop & Van Leeuwen, 2016).

In both the developed and the developing parts of the world, urban water governance is confronted or is prone to a variety of challenges and failures, related to the special nature of water, causing dissatisfaction, malfunction and need for re-routing towards more holistic, flexible, adaptive and interdisciplinary approach. These challenges commonly include legal, legislative, economic, political, administrative, capacity, accountability, information and placing priorities issues, which many times are also interrelated and codependent. In order for these bottlenecks to be counteracted, many concepts and principles have been developed, from both governmental and non-governmental organizations, internationally.

Among these concepts proposed are the ''Integrated Water Resources Management'' (IWRM), the ''Sustainable Urban Water Management'' (SUWM), the ''Water Sensitive Urban Design'' (WSUD), the ''Water Sensitive City'', the ''Smart Cities'' and the ''Water Wise Cities''. The bounds among them are blurred, having many elements in common.

All thing considered, the need for a paradigm shift in the current water management practices is unquestionable, yet it should be pointed out that there is no single or ideal solution appropriate to each case and region, rather than a range of potential actions and approaches, taking into account the overall background of each particular case, so as to develop a model of action that meets the specific needs, using the existing infrastructure.

As a future work, research on the national and local state water management and governance in Greece is proposed, to determine the current difficulties, practices, limitations and benefits, as well as opportunities, in order to move into higher degree of water sensitivity and sustainability.

1. Introduction

1.1. Water value and emerging water-related pressures

It is widely accepted that one of the most looming international concerns in the last decades is the environmental downgrading, as it is depicted, for instance, in the *Global Risks 2018* (World Economic Forum, 2019), where ''environmental dangers'' are ranked 3rd among the four categories of risk-trends.

Water is a fundamental player in almost every emerging environmental problem. Generally speaking, there is a loop-vicious circle, where climate change, which leads to more extreme and recurring weather events, such as stark temperatures, acute precipitation, floods, droughts (National Climate Assessment) and human activity deteriorate the water quality and quantity, globally. This has brought about the introduction of the term ''water crisis''.

1.1.1. Water crisis

Although there is a debate even for the existence of the so-called ''water crisis'' (Castro, 2007), the proponents of that term underline its multi-metric nature (Castro, 2007), which is basically related not to complete shortage of water, but to phenomena such as injustice in water sharing and imbalance between water supply and demand (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010). However, the nature, frequency and severity of the water-related issues are not the same everywhere. Water crises have been manifested in variant forms and scales in many places in the world and their importance has diverse meaning for different people and parts of society (Olsson & Head, 2015). There is no simple explanation for this different understanding of the problems, although it can be deemed as rational, considering the unequal distribution and differentiated perception of water throughout generally the world and specifically every society.

Particularly, for the first point, from the approximately 2.5 % of the total water volume on earth which is freshwater, only a fraction is suitable for human use and that fraction is not evenly allocated geographically (Castro, 2007).

Regarding the second point, undoubtedly, freshwater is a public good essential for life and prosperity, precious as *''blue gold''* (Moss & Newig, 2010), but at the same time the notion about water diversify from people to people. For example, according to Gupta & Pahl-Wostl, 2013 water is perceived ''*as a sacred commodity, e.g., in Indian mythology; as a heritage (European Parliament and the Council of the EU 2000; as a social, an economic (ICWE 1992), or a political good (Schouten and Schwartz 2006); as a security issue (Gleick 1993, cf. Levy 1995); as a hydrological entity, by hydrologists; and as an ecosystem medium (Sneddon et al. 2002) that*

provide ecosystem services (MEA 2005).'' For Valkam et al., 2008, cited in (Lerer, 2015) there are 12 aspects of water: biophysical aspects (physical, chemical, biotic), human aspects (psychological, logical, historical, linguistic, social, economic, aesthetic, legal, moral). As a result, different actors in the water ''system'' give priority to other aspects and that generates dialogue-competition among them (Gupta, 2013). In this issue we will return. Water is also a geopolitical recourse that influences countries relations, since nations might be ''water dependent'' (Hoekstra, 2010). According to Hoekstra, a country can be dependend either on neighboring countries water or on virtual water import. As virtual water import dependency, Hoekstra, based on FAO, defines the ratio: (*water volume that is not generated in the country/total volume of water) needed to produce the goods and services consumed by country's citizens.* Increased ratio (>25-50%) is often translated into water-scarcity conditions. Among the countries with high depedency ratio are mediterranean countries such as Greece, Italy, Spain, Portugal (Hoekstra, 2010).

1.1.2. The need for a change

It is probable that the appearance of a crisis might considered not only as a need but also as an opportunity for rethinking the nature of the issues and the possible steps aiming to combat them. A crisis can motivate change (Olsson & Head, 2015) and raise awareness. The measures implemented in order to adress a problem can be reactive or proactive. Reactive measures are taken under the pressure of a specific situation in need for solution within a certain time period, for example a flood. Therefore, there is high probability for these proceedings to be suboptimal, expensive or ineffective. On the other hand, proactive measures rather hinder than simlpy try to fix a problem, giving space to more adaptive approaches, that include policy novelties and experiments and respond better in uncertain conditions. (Olsson & Head, 2015; Elelman Richard, 2018; Koop & Van Leeuwen, 2016)

1.1.3. The role of urban areas and water-related urban challenges

One of the most critical questions in the environmental and especially water-associated matters is the appropriate scale for the analysis, as well as the starting point of it. For the vast majority of the countries in the world, the starting point for almost every kind of activity is urban areas. Cities are the core of social, economic, tecnological, cultural growth and innovation (OECD, 2015) and *''global change makers''* as well (Koop & Van Leeuwen, 2016). Better opportunities make people move massively to urban areas. Although population increases with varying rates across the globe, it is estimated that world population is about to rise from about 7.6 billion in 2018 to 8.3 billion in 2030 (UN Population Fund, UN). It is expected that this augmentation will be absorbed mainly from the cities over the next years (Koop & Van Leeuwen, 2016). Furthermore, cities can be considered as midpoints of *production, consumption and waste,* thus more and more hinged on rural areas, for

water, energy and material providing. (Koop & Van Leeuwen, 2016). Except climate change and increased urbanization's concequences, other water related sectors present in urban regions- pollution, scarcity, salinazation, erosion, competition among domestic, industrial and agricultural users, ageing, poor maintained or non existant infrastructure- threaten smooth operetion and stability and also demonstrate how outdated and unsufficient for the future current practices are. (OECD, 2015; Koop & Van Leeuwen, 2016). Of course, city's exposure to and affection by these challenges and also its respond capacity differ. For this reason, (OECD, 2015) proposes a set of critiria for the situation of the cities among similar ones, in order to tailor their action towards future water problems. Classification of these critiria falls into three categories:

- Exposure to water risks: floods, scarcity, pollution, ecosystem resilience, dominant water resourse (surface or groundwater), location of the resource (local or distant), reliability of the resource (renewable or non-renewable source;water stress level), geografical features
- Distinctive urban features: affluence (in terms of quality and quantity water demand, infrastructure, financing), energy endowment, surroundings (urban, rural, coastal zones, deltas), size (large cities: greater impact on ecosystems and more opportunities to face the problems), urban dynamics (population growth, infrastructure, investments), spatial patterns (compact or sprawling)
- Institutional architecture: fiscal autonomy, informal/soft coordination, inter-municipal authorities, supra-municipal authorities, metropolitan cities

As the need for a paradigm shift is once again obvious, cities, expresing pioneering spirit, are expected to make the difference adopting more coordinated, far-sighted and holistic approaches on water-connected policies and actions which are embedded in the water management framework.

1.2. Content of the chapters

The present thesis's layout follows, describing the context of each chapter.

Chapter 1: Introduction – In this chapter, a general introduction is presented, discussing the special water value and the current water-related challenges and crises that humanity faces, which have triggered the need for a paradigm shift, especially in urban areas, the importance of which is also pointed out.

Chapter 2: Water management – In this chapter, after defining the term ''management'', an analysis of the importance and the traditional and current forms and tendencies of water management and urban water management follows. In addition, issues of water security and sustainability are also included.

Chapter 3: Water governance – In this chapter, the concepts of governance in general and water governance specifically are explored, with emphasis on the current water governance challenges and on the attempt to achieve good governance, adopting corresponding practices.

Chapter 4: Towards water sensitive cities – In this chapter, the concepts that have been developed in order to reach sensitivity and sustainability in urban areas are presented, including the ''Integrated Water Resources Management'' (IWRM), the ''Sustainable Urban Water Management'' (SUWM), the ''Water Sensitive Urban Design'' (WSUD), to conclude on the ''Water Sensitive City'', the City Methodology Blueprint, the ''Smart Cities'' and the ''Wise City''.

Chapter 5: Conclusions –In this chapter, a summary of the thesis and proposals for further research are given.

2. Water Management

2.1. Management

With the term management, Cardwell Hal, Cole, Cartwright, & Martin, 2006 define the necessary practices or actions taken in order to reach a given end. In other words, from personal to country's decisions, management of the situations is the process that is followed. At the same time, effort is made in order the selected solution to have maximum benefits and minimum side-effects. Since this condition is almost impossible to be achieved, optimization is the next process in management procedure.

2.2. Water management-traditional tendencies and present perspective

As water is sine qua non condition of human life and well-being, water management history is presumably as ancient as human history. Typical examples of water management in historical times are the admirable handling of Nile River in ancient Egypt, (vital for its development) and that of the ancient city of Athens, a region with scarcity uncertainties, where infrastructure construction in combination with official strict rules ensured rational water use and consequently, sufficiency.

Water management is a complex set of practices and decision-making processes, in order to be ensured that human-environment interaction provides the protection, maintenance and enhancement of water cycle operations and benefits, such as public health, supply and risks security, economic development, equity, recreation (Wong & Brown, 2009; Hooper, 2003).

In the modern world, traditional water management was single-sector oriented, with problem-solving approach. In other words, the emphasis was given on the optimization of some aspects of water cycle, ignoring the others (single-sector oriented), with main goal the maximization of development, using technological state-of-the-art means. (Hooper, 2003; Wong & Brown, 2009; Ashley et al., 2013) Design and operation of supply and sanitation infrastructure were isolated, institutionally divided, energy-intensive, without special provision for resource rehabilitation, urban livability or water treatment at source (Ashley et al., 2013).

After the movement for the environment in 1970's, this conversional management perspective has been questioned (Hooper, 2003), since it had become evident that the reciprocal influence between water sector and other crucial areas, as urban plan, energy sector, transportation systems, production sector, agriculture is very strong and important to be ignored anymore. Therefore, a more comprehensive management framework, which took into consideration *all* that connections and components has developed, named ''ecological'' or ''ecosystem'' approach (Hooper,

2003). This concept might be considered as precursor of ''integrated approach'', which will be described in detail later. The main difference of the two approaches, in Mitchell's (1991) interpretation cited in Hooper, 2003, is that integrated concept targets the participation of *key* components, not of all, as in ecological approach, for gaining practical value. Otherwise, with the participation of all the actors related the transition, design and application of the framework would be time-consuming more than the desirable, jeopardizing the plan's effectiveness.

Recently, internationally, water management is a means to accomplish water security, fairness and sustainability in water use, so as to soothe water risks. For OECD, 2013, water management aims at decreasing risks and allocating the remaining ones.

2.2.1. Water security, Sustainability

Water security, according to OECD, 2013, is the maintenance in an acceptable level four water-connected risks, as described below:

- Shortage-droughts: insufficient water quantity to cover short- or long- term households, ecosystems and production sector's demands
- Unsuitable quality level for particular use (pollution)
- Excess-Floods: abnormal overflow of a natural or built water system or detrimental accumulation of water over land
- Degradation of freshwater systems' resilience: surpassing surface and groundwater bodies' capacity, causing irreversible harms to their biological and hydraulic performance. A resilient system may: absorb without change certain amount of disturbance, be self-organized, be adaptive (Folke, 2006, cited in Wong & Brown, 2009).

On the grounds that risk includes the likelihood and the potential consequences of an event, the steps required for applying a risk-based approach on water security are (OECD, 2013):

- Knowledge of the risk: common understanding, scientific evaluation, stakeholders' point of view
- Delineation of acceptable level of the risk: not implicitly, but taking into account the social, economic, environmental dimensions of a water risk and the cost of improvement
- Handling of the risk: cost-effectiveness, social equity
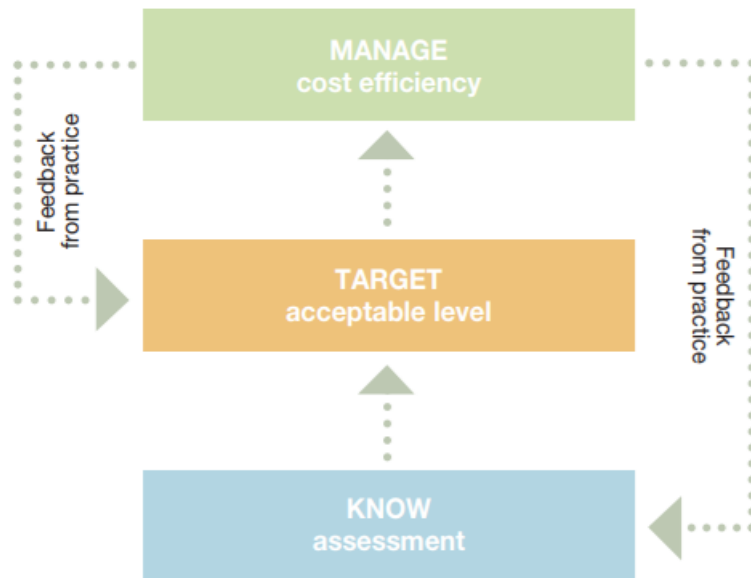
Figure 1: Flowchart of three-step risk-based approach (Source: OECD, 2013)

Furthermore, water security entails the balance between resource protection and consumption, in local, regional, national and international level (GWP, 2000), as well as the provision that every action taken to combat risk not to deteriorate other kind of risk (OECD, 2013).

Sustainability is a development concept with central objective the guarantee of meeting both current and future humanity's needs (UN, 1987) and concerns society, economy and environment.

2.3. Urban water management – A framework

Many countries in the world have succeeded a satisfactory level of water security, providing for their citizens public health and well-being, ecosystem protection and economic vitality, as result of usage of technologies, financing tools and institutions. Nevertheless, challenges that generate uncertainty are not absent. Apart from those already mentioned above, other challenges are caused, inter alia, by the diffusion of pollution, the stricter environmental and health criteria, the failure in the attraction of new investments. (OECD, 2015).

Regarding the policy options in urban water management, there is the dipole centralized-localized systems and in the middle, more integrated approaches. The first category of the dipole includes expensive large infrastructure and organizations responsible for large populations, while the second is referred to decentralized, low-cost options, suitable for the specific local conditions. (Huitema and Meijerink, 2010, cited in Olsson & Head, 2015)

For the attainment of the desirable current and future water security level with the minimum cost to the society, the OECD (OECD, 2015) has designed an urban water management framework for OECD cities, combining four interacted dimensions:

- Financing
- Innovation
- Urban-rural interface
- Institutional arrangements→*Governance*

In the figure below this framework is analyzed further.
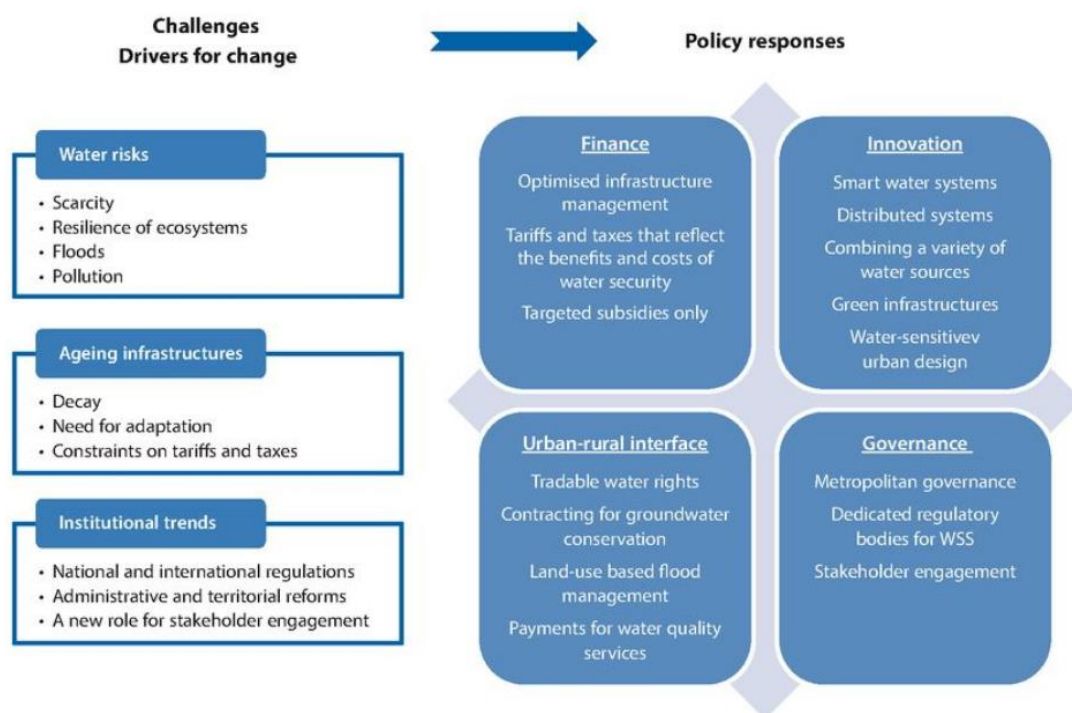
Figure 2: A city level water management framework (Source: OECD, 2015A)

As it is demonstrated above, governance is one of the four pillars of water management and the next chapter is dedicated to its analysis.

3. Water Governance

3.1. Exploring the concept of *Governance*

Over the last years, there has been much debate conducted on governance generally and water governance especially (Bakker & Morinville, 2013). As it is logically inferred *water governance* is a part of *governance* in general. So, the first step in order to study water governance is to better analyze the term *governance,* since *governance shift* is considered as one of the main steps in the transition path towards a more sustainable future. (Koop & Van Leeuwen, 2016)

3.1.1. Definitions of *Governance*

There is no a clear-cut answer in the question *what is governance*, even though there is an almost blanket acceptance of its importance. This is partly due to the dissimilar political and academic background, which generates conceptual vagueness and different perception and practices of governance. (Castro, 2007). Of course, every country has already developed its own governance scheme and the objective now is to enhance its effectiveness (Rogers & Hall, 2003), as it will be discussed later.

Governance structure has a dynamic nature, since it changes in time and space, and it may have many different forms depending on the diverse cultural, historical, geographic, political, legal and administrative background, along with the climatic and economic conditions and social and other circumstances. (OECD, 2018; Rogers & Hall, 2003). As a result, different governance schemes are produced by different cultures. (Castro, 2007). For instance, a first general distinction might be that of the developing and the developed countries in the world.

There is no one and only acceptable definition of the term governance globally, but there is general agreement that governance transcends government-which was the previous primer factor in society's forming, as well as in political decision-making-and also regulation, public management and traditional hierarchical activity (Biermann cited in Olsson & Head, 2015) and recognizes the influence of a plethora of actors and their pluralistic interplay. (Olsson & Head, 2015). Therefore, the concept of governance has a broader spectrum than government per se, due to the fact that governance also comprises the correlation between society and its government (Rogers & Hall, 2003), and it also embraces dynamic, pluralistic and equal involvement of the state and society, since the cooperation among statal, private and societal actors is considered to be more productive and beneficial for the legit and efficient public goods' provision (Blatter, 2012). In light of this, governance can be considered as a ''*transdisciplinary bridging concept*'' (Blatter, 2012). As main governance dimensions, the (UN) deem the following: economic, social, political-

administrative and ecological (Koop & Van Leeuwen, 2016). In the latter category belongs the water governance that it will be analyzed afterwards.

As it has already been referred, it is not simple to define the term governance, due to its complex nature. Generally speaking, governance expresses the systems of organization of a group of people or of society on the whole, on the grounds that it delineates who has the authority for decision-making, how decisions are made, how other actors participate, who is responsible (accountability) (https://iog.ca/what-is-governance), or, to put it differently, governance is the answer in the question *who does what?* (Koop & Van Leeuwen, 2016)

For Pierre and Petersas cited in Gain, Rouillard, & Benson, 2013, governance is mostly the product of the activities of governments and various other actors on the basis of acceptable institutional norms and behaviors. Among these actors can be fall institutional authorities and regulators, service providers, business and industry, scientists, researchers and academia, civil society, customer associations, trade unions and workers, international organizations, pressure groups, advisors and media (OECD, 2015 A). All these and other possible factors engaged have different role, objectives, power, motives, expertise and knowledge, influence, voice and importance, as well rights and obligations. In addition, in the majority of cases, the *State* is focal actor (Blatter, 2012).

For UNESCO, 2006, p.410, cited in Castro, 2007, *''Governance strategies should be selected to optimize the achievement of societal goals. In this context, valuation can be viewed as a fairly neutral and objective process by which social goals and trade-offs can be identified and debated and the optimal governance strategies chosen''*. In this definition, there is no a hint for the process and the responsible by whom these societal goals are defined (Castro, 2007), and also governance it is considered as a neutral and objective procedure. However, that statement might be controvertible, considering, for example, the point of view of Rogers & Hall, 2003, according to whom governance is strongly political issue, as it concerns the implementation of socially accepted regulation and allocation. Indeed, in an ideal world governance procedures would be neutral and without bias. Yet, in real world that is difficult to be achieved, as various interests, pursuits and power asymmetries are involved, rendering concomitance complicated. Of course, any kind of complexity must not be an alibi for inaction. Besides, tools have been developed in order to assist cooperation and ensure proper function of the system, as it will be described later.

In the EU, governance is a *''multi-layered, multi-scale and multi-sector ensemble, characterized by a combination of hierarchical structures, participatory dynamics, associative action and market mechanisms and would be based mainly on a culture of dialogue, negotiation, active citizenship, subsidiarity and institutional strengthening''* (HEINELT et al , 2002, cited in Castro, 2007)

According to Blatter, 2012, there is a variety of meanings and explanations of the term governance, because it is used both as *''a generic fundamental concept''* that includes the institutional forms of social coordination, and as *''a new specific form of governing''*, opposing to older forms.

From social-political science view, the term Governance has been extensively used at the beginning of the millennium, expressing new forms of political integration and steering. (Blatter, 2012)

For Blatter, 2012, the term Governance includes a *normative* and an *analytical* dimension. The normative understanding of governance can be described as a *''programmatic alternative to other paradigms for organizing and reforming the state and public administration. The competing paradigms can be subsumed under the terms government and management.''* (Blatter, 2012). The analytical understanding of governance is used to describe the changes in political steering forms or even in statehood and politics. (Blatter, 2012)

From law-based perspective, State is *''the instrument for the realization of the people's or citizens' will, which is determined by means of public deliberation and/or through formal aggregation and coordination procedures (votes/prices)''* (Blatter, 2012). This is an instrumental *view* of governance, which should not lead to ignore the intricate structures and links that form governance (Castro, 2007).

In addition, according to Lange et al, 2013, cited in Koop & Van Leeuwen, 2016, there is a differentiation among *''political processes (politics), institutional structures (polity) and policy content (policy)''.*

As Scott, 1995, cited in Brown, Keath, & Wong, 2009 claims, **i**nstitutions are founded on three pillars:

- *Cognitive: dominant knowledge, thinking and skills*
- *Normative: values and leadership*
- *Regulative: administration, rules and systems,* adapted to the cognitive and normative pillar.

In order for an institutional shifting to be achieved, it is necessary every pillar to be changed, as they are described above, and not only one of them at the expense of the rest, as it occurs often. For instance, regulation is altered, without a corresponding shift in existing thinking and values, due to powerful stakeholders' influence, even though the opposite it is the logically expected. (Brown, Keath, & Wong, 2009)

As Heley, 1997, cited in Brown, Keath, & Wong, 2009 distinguishes institutions can be manifested by *''hard''* and *''soft''* infrastructure. *Hard* infrastructure includes

formal institutional bodies, regulation, taxes and funding and *soft* infrastructure encompasses informal networks, professional and social groups.

Generally speaking, every governance system takes place and is applied in levels, which range from *subnational to national, regional/transboundary and international.* (Providoli, et al., 2017)

3.1.2. Ideal, existing and emerging forms of *Governance*

In the literature, in an attempt of deeper understanding of governance concept, there are three primary institutional forms of external governance: hierarchical, network and market, the ideal features of which are described below.

Hierarchical governance is characterized by formal domination and subordination ties or, in other words, by vertical asymmetric interaction between the ''rulers'' and the ''ruled''. Legislation is enforced authoritatively and in non-negotiable manner and any possible violation is punished by penalty measures. In the EU, hierarchical governance is usually closed to the ''*Community Method*''. In this traditional policy-making practice, supernatural institutions produce potent supernatural law that might be implemented and controlled by the European Court of Justice. (Lavenex & Schimmelfennig, 2009)

Network governance, on the other hand, is characterized by formal relationship of equal rights. That does not eliminate the asymmetric power of on part over the other, but, generally, there is interaction and reciprocal agreement in the production of law instruments. Another term of network concept is ''negotiation system'', because of the use of negotiation and willingness to agree in possible quarrels instead of using the law. In the EU, the application of network governance may be evident in decentralized institutions, for example committees, agencies or policy networks that are founded on working expertise in place of political connections. In these organizations, present might be, except for participants from the member states, other international and private actors. Further qualities of that type of governance are the opportunity of ''*socialization, social learning, communication, deliberative processes, co-ownership, density of interaction*'' (Schimmelfennig and Sedelmeier, 2005, cited in Lavenex & Schimmelfennig, 2009), which makes that concept easier to apply in the case of international rules in common. (Lavenex & Schimmelfennig, 2009). As *social learning* can be described a *learning by doing* repetitive and explanatory process of interchanging experiences and knowledge among actors, so as to facilitate the settlement of relevant issues (Bakker & Morinville, 2013). Other authors use the term *distributed governance* to depict similar governance system, for example (Rogers & Hall, 2003).

Market governance is characterized by results derived from competition among officially independent players. Markets nature as form of governance is sometimes questionable, because of the absence of all-encompassing rules' system, which is typical trait of political systems. High extent of economic liberalization and devolved and sectorally divided state framework that permits expert and stakeholder's involvement are prerequisites for market governances. In the EU, market governance is expressed, for instance, in the Single Market, with main aim the provision of the free movement of goods, with high standards and environmental protection (https://ec.europa.eu/growth/single-market/goods_el). In this governance system the consumers' demand defines the prevalence of the most competitive products and services. (Lavenex & Schimmelfennig, 2009).Many researchers claim that this concept is too simplistic and does not fully represent broader values of society. (Rogers & Hall, 2003)

Table 1 Structural modes of external governance (Source: (Lavenex & Schimmelfennig, 2009))

	Actor constellation	Institutionalization	Mechanism of rule expansion
Hierarchy	Vertical: domination and subordination	Tight, formal	Harmonization
Network	Horizontal: formal equality of partners	Medium-tight, formal and informal	Co-ordination
Market	Formal equality of partners	Loose, informal	Competition

As it has been referred previously, the historical governance context changes over time and space. For instance, in Europe and North America, a strong State, assisted by capital investment and industry, was the dominating actor in shaping governance schemes. Nevertheless, this conventional political reality is changing in the last two decades, when the statal institutional power is being under dispute. Many social and economic changes have enabled this procedure of governance transformation. (Rogers & Hall, 2003; http://iog.ca/what-is-governance/) Among them one can notice:

❖ Within the State:
- Fiscal crises
- Increased population and political power in urban areas
- Stronger sub-national democracy in urban or semi-autonomous areas
- Increased responsibilities and amount of work on smaller bureaucracies

- ❖ Internationally:
  - ▪ Technological development that promotes networking and subsidiarity. *Subsidiarity* is a principle according to which a central authority does not act unless it is more effective than action taken at lower levels, for those fields that it is not solely responsible (Bakker & Morinville, 2013).
  - ▪ Globalization, which lessens the state's ability to control the economy, through volatility of capital and deregulation of financial markets

Deriving from the features above, current novelties added in traditional types of political practice are market-based and voluntary structures, with the participation of state and not state actors (such as society, private sector) and a certain extent of self-regulation and coalitions (Olsson & Head, 2015), that is to say that there is a shift from hierarchical structures in a vertical relation system and centralized institutional setting, to *partnership-like* scheme on the basis of horizontal relations and decentralized administration frame (Blatter, 2012; Rogers & Hall, 2003). These new functions have triggered the foundation of new institutional arrangements, agencies, commissions, corporations and boards in charge to regulate, council, adjudicate and deliver services as well (https://iog.ca/what-is-governance).As a result, there are a number of existing governance forms, including *central, decentral, public-private, interactive* (Driessen et al., 2012, cited in Koop & Van Leeuwen, 2016) and the existing relationship between government and governed is highly complicated and multifaceted (https://iog.ca/what-is-governance), characterized by mechanisms of competition, negotiation, trust, exchange, unilateral exertion of power, mutual or one-sided adjustment (Benz, 2004, cited in Blatter, 2012).

As the state is no longer believed to be capable of addressing societal, environmental and other problems and crises alone, there is a need for state's adaptation to new forms of governance, responding to its external evolving environment (Rogers & Hall, 2003). This adaptation is easier to be succeeded through participative processes among actors involve, which are actually, as it has been mentioned, governmental and non- governmental, and with increased number, comparing to the past. In this context, emerging governance approaches are that of *polycentric governance* and that of *adaptive governance.*

Polycentric governance is a concept in which decision-making processes is a fruit of several independent *centers and actors*. (Bakker & Morinville, 2013)

Adaptive governance is a form of governance with *polycentric institutional and decision-making arrangements,* which relies on networks that bring together institutions, organizations, agencies as well as individuals. Social learning, polycentrism, broader participation and collaboration are important in this concept,

for better adjustment to the changing conditions. (Bakker & Morinville, 2013).This claimed flexibility that also bring resilience is one of the most important arguments in favor of that governance form. On the other hand, opponents of this concept question its feasibility given a variety of constraints, such as operational, in resources, bureaucracies with overlapping functions. (Bakker & Morinville, 2013)

Multi-level governance embraces rescaling towards three directions *''"up" from nation states, "down" to local levels of government and "out" from geopolitical units (for example the nation-state, the province) to new scales (watersheds,* alias *river basin)."* (Batterbury et al, 2006 and others cited in Bakker & Morinville, 2013)*.* That rescaling procedures are not uniform, and many question the ease with which that can be possible in terms of space, time and direction conditions. (Bakker & Morinville, 2013)

A common feature in governance systems is the effort to balance power and priorities, since governance is the central decision maker in the society, taking into account external and internal forces and pressures, such as public preferences and ambitions, international agreements and treaties, short-term political expediencies, decentralization, donor priorities etc. (Bakker & Morinville, 2013). As a consequence, the governance systems need to be strong and sound, so as to have the capability of making the best of the benefits, avoiding the risks of short-term interests (Rogers & Hall, 2003).

3.1.3. Current challenges of *Governance*

Acting and interacting in a changing world is on its own challenging and complex. This developing reality, along with multiple pressures and challenges, some of which have already been referred, at national and international level, have brought about urgent necessity, as well as willingness to change, in every part of human activity. When it comes to governance, it has been said previously that new types of governance concepts are arising. Policy failures, inadequacy and inefficacy in addressing current pressing issues are major motivations for these noticed governance shifts, which are relative to the prior situation in every part of the world.

Several challenges related to governance have been observed in the modern world, as it is follows (https://iog.ca/what-is-governance; Knill and Tosum (2008:9) cited in Mwije, S., 2013). To begin with, an important issue that governance have to handle is the population of the world, in terms of increased or decreased birth rates in different parts of the world, which influence the every country's function, as well as the whole world generally and variously. Another matter that is concerning is the changing relationship between citizens and their government, as a consequence of a shift on prevailing perceptions, especially of the latters', regarding to their role and expectations, and betterment of the quality of life as well. State-of-the-art

technologies transform a broad range of human activity, from decision-making to service delivery to citizen participation. This, along with the following information revolution and the improved educational attainment (especially in developing countries) strengthen the people's voice, making them to want to have more active involvement in social and political affairs, as well as to demand more control, openness, transparency and accountability on government performance. Thirdly, a series of challenges that modern governance faces are related to limitations of time, many kinds of resources, expertise and policy formulation, in parallel with bureaucratic malfunction, which causes a non-stop cycle of even contradicting decisions, legislation and policies. This phenomenon becomes more complex, considering the development of informal institutions and the international agreements, risking eventually the effective law making and enforcement.

3.2. Defining Water Governance

Water governance evidently is part of the general policy framework set by government. (Rogers & Hall, 2003). However, actual global environmental, economic and social crises have changed the operation of government decision-making. In addition to this, the often assertion that the water crisis that many countries in the world confronts is more a governance crisis (World Water Council, 2003), indicating that poor governance of water management is a major contributor to environmental degradation (Olsson, 2015), have brought about new discussion for the water governance concept and procedures, with core aim to change the perception that water is *''many people's concern, but often nobody's business''* (Global Water Partnership, 2000). But, what is defined by the term water governance? Once again, similarly to defining governance, there is no internationally agreed definition for water governance, due to the fact that its pluralistic nature makes that difficult. Therefore, many approaches might be followed. (Rogers & Hall, 2003). For example, focus points may be the match and mismatch of ecological and politico-administrative systems and operations, the human rights and democracy concerns or the financial and political accountability and efficiency. (Rogers & Hall, 2003). Yet, it is widely accepted that water governance is of crucial importance for sustainability of ecosystems and water security. (Bakker & Morinville, 2013)

The Global Water Partnership, 2002, cited in Rogers & Hall, 2003 defines that *''Water governance refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society''.*

According to the OECD, water governance can be described as the *''range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can*

articulate their interests and have their concerns considered and decision makers are held accountable for water management'' (OECD, 2018)

Comparing the above definitions of these prominent organizations, it is understood that they express the same angle on the water governance matter in general, except for the fact that OECD emphasizes on stakeholder participation and rule makers' accountability, as well as the informal nature of some processes, whereas the Global Water Partnership stresses the multi-level dimension of water governance.

Other similar definitions of water governance include:

''Water governance includes institutions, organizations, policies and practices, which shape and manage water resources, including the delivery of water services for diverse populations and industries.'' (Olsson & Head, 2015)

''Water governance covers the mechanisms, processes and institutions, by which all stakeholders, on the basis of their own competences, can contribute their ideas, express their priorities, exercise their rights, meet their obligations and negotiate their differences.'' (Koop & Van Leeuwen, 2016)

According to Bakker, 2003, cited in Bakker & Morinville, 2013, water governance is determined as *''the range of political, organizational and administrative processes through which community interests are articulated, their input is incorporated, decisions are made and implemented, and decision-makers are held accountable in the development and management of water resources and delivery of water services.''*.

Taking the above definitions into consideration, it can be claimed that water governance is a suite of procedures based on decision making methods among different levels and various sectors, stakeholders and authorities, perspectives and interests, so as to establish water management, for resolving water related issues. (Hooper B., 2006; Koop & Van Leeuwen, 2016)

Water governance nature is complex and interactive with biophysical, social and technical systems, and to some extent, also uncertain, fact that must be accepted and taken into account (Bakker & Morinville, 2013). Water governance structures and institutions offer to all stakeholders the opportunity to learn the stakes, manifest their viewpoint and priorities, practice their rights and duties, as well as negotiate their interests with one another (Koop & Van Leeuwen, 2016), so the proposed public policies to be socially acceptable (Rogers & Hall, 2003). Principal aims of urban water governance are to ensure water supply in cities whensoever, in a fair way and fulfilling healthy and environmental quality standards (Olsson & Head, 2015). However, for many authors as the (Castro, 2007), *''in practice, water governance consists in the interaction between governments, large businesses, political parties, civil and other organizations representing sectoral interests,*

international agencies, NGOs and other relevant powerholders …debating on how water and essential water services should be governed, by whom and for whom". As a result, different aspects of water value are promoted, in each case, for example for some water is primarily a public good, while for others is an economic good. (Castro, 2007). So, it is apparent that the policy framework is of the key determinants of the protection and provision of which of water services, to *"whom, when, where and why"* (Gupta & Pahl-Wostl, 2013).

A distinction of water governance is possible to be made, regarding the structures and procedures within the water sector, and we speak for *internal* governance, while the *external* governance concerns the links of governance with other domains, such as society, law etc. (Rogers & Hall, 2003)

Bakker & Morinville, 2013 consider water governance as one of the three concepts (water security and IWRM the other two) that are on the center of water-connected research the last years. However, water governance can be considered as a hierarchically superior notion of the others, which are dealt as concepts belonging to the idea-umbrella.

In addition, Rogers & Hall, 2003 make a distinction between the *functional levels* of water governance. According them, these are:

- *operational level:* includes public or private enterprises in order to use water for covering specific needs, for example water supply, wastewater treatment, irrigation, hydropower, tourism
- *organizational level:* includes public or autonomous (for increased impartiality) administrative bodies, in charge to regulate and control water use, so as for the conflicts among users to be lessen and for the action measures to be coordinated
- *constitutional level:* creates the environment so the other two functional levels work, by setting legislation and policy measures

3.3. Facing current water governance challenges

For numerous countries in the world water is treated as state property. Statal agencies in charge control the handling and use of water resources, acting, theoretically, on behalf and in the interests of citizens, through legislation. In addition to this, in many cases, the aim is the lesser private ownership possible (Rogers & Hall, 2003). Generally speaking, fair and efficient water exploitation is staunchly believed that can be accomplish by politics (Rogers & Hall, 2003), through appropriate prevention and encouragement measures.

However, in both the developed and the developing parts of the world, urban water governance is confronted or is prone to a variety of challenges and failures, related

to the special nature of water. Water links people, places and sectors (for example environment, health, agriculture, energy, land use planning), so it becomes local and global concern as well, and, due to its unparalleled preciousness, it is an extremely monopolistic and capital-intensive good (OECD, 2018).

The existing challenges and failures that modern water governance faces in many places of the world, which have also cause dissatisfaction, malfunction and need for re-routing, commonly include legal, legislative, economic, political, administrative, information and placing priorities issues, which many times are also interrelated and codependent.

For instance, legal challenges may involve water rights questions, which can be either formal or informal (based on cultural and traditional practices) (Rogers & Hall, 2003). Water rights can define stakeholder participation and their rights and obligations, as well as to provoke conflicts, due to the unfair and unequal water availability and distribution, as well as unbalanced power over the relevant procedures. Apart from this, there is a developing pressure for formalizing water property rights (Rogers & Hall, 2003). This is not an easy task, engaging a lot of parameters, the basic of which is the notice that the formalization of water rights may not always lead to better application or wiser water use. On the contrary, it is possible to trigger severe conflicts, as well. (Rogers & Hall, 2003). In light of this, it is stressed once again the importance of both the background of each case and the balance between individual's power and interests and the common good. In fact, water is considered as a more possible cause of conflicts internationally and intra-nationally than oils (GLEICK 1991, 2000, cited in Castro, 2007). Water conflicts forms can range from peaceful gathering to demonstrations, refusal to pay water-bills or taxes, even infrastructure destruction and bloody confrontations (Castro, 2007). Relevant is also the discussion of the participation of the private sector in water services. Although the analysis of this controversial issue is beyond the objectives of this master thesis, a brief notice will be given; maybe and in some cases, it is not only the nature of the provider (public or private) that can affect negatively human rights on water, rather than the taken policy measures, even though it is widely accepted that private sector should not control or own water utilities (Rogers & Hall, 2003; WBCSD, 2002, cited in Rogers & Hall, 2003).

Legislative challenges include difficulties in codifying rights and responsibilities, in keeping pace with international agreements and plethora of laws, as well as in making, implementing and controlling national legislation. When multiple policies are applied at the same time, in the same area (*legal pluralism),* sometimes even conflicting ones*,* there is a possible risk of confusion, which can be proved unproductive (Gupta & Pahl-Wostl, 2013).

Economic challenges vary from deficient financing and taxes collection, to pricing issues, conflicting interests and power dynamics, expensive yet ineffective state machinery (Rogers & Hall, 2003), as well as monopolies, privatization and corruption.

Especially regarding corruption, overcoming this phenomenon must be of primary priority for governance, due to its negative effect not only in the economy per se, but also in social trust and acceptance. Means to achieve this aim are either law, which might be proven expensive, or even through a more distributed governance schemes that promote open competition, transparency and accountability and discourage corruption attempts as well (Rogers & Hall, 2003).

Political challenges may start from obstacles in problem framing (Olsson & Head, 2015), as a result of many different viewpoints and interpretations upon water issues, and also they are connected to issues such as lack of political will, vision leadership and proper orientation of politic agents (Rogers & Hall, 2003). Moreover, it is not rare for water governance to deal with problems such as interception of political creativity by institutional structures, while, on the contrary, services dysfunction, as a result of political intervention or disagreements (Rogers & Hall, 2003). In addition, more often than not governments have opposing responsibilities, being both providers of services and controller of accountability, leaving with low or none responsibilities local authorities and civil society (Rogers & Hall, 2003). As a consequence, inter alia, local public society and organizations are not accountable for the action they suggest (Rogers & Hall, 2003).

Administrative challenges cover bureaucracy, many related authorities with vague and sometimes overlapping responsibilities, inadequate coordination and deficient dialogue among different sectors (Olsson & Head, 2015), which can cause developmental and organizational delays and malfunction, among other operational problems. Scale matters also play a prominent role in the overall picture, since water resources management and governance are practiced on many spatial scales, considering water biophysical nature and current institutional structures, practices and dynamics (Moss & Newig, 2010). A significant question on water resource governance in the modern world is raised regarding its *spatial scales* and *multiple levels* of action, in other words, which spatial scale or level is suitable for which water management aspect. On the one hand, there is generally a mismatch in administrative and in the relevant hydrological systems' levels and boundaries and, on the other hand, stress is developed between the conventional national *nested hierarchies* and the new trends of *upscaling* (toward national or supranational scale, i.g. transnational agreements), or *downscaling* (decentralization, local or regional scale) of environmental governance. Upscaling is basically strengthened by the demand for global challenges' control (for example climate change, virtual water and others), while decentralization and public participation can be better applied in smaller governance areas. There are also *adaptive* proposals for local water self-management (Olsson and others as referred to (Moss & Newig, 2010)) and the prevailing paradigm of EE's Water Framework Directive that, as it will be presented afterwards, although it is based on river basin management, it also encourages inclusive forms of governance, as well as interaction between and within political

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and hydrological scales. (Moss & Newig, 2010). As a result, spatial externalities and decreased efficiency and effectiveness of water governance are induced and re-scaling processes and *new task-specific* governance levels are about to be created. (Moss & Newig, 2010)

Information challenges concern, on one hand, general public, society and related stakeholders. For example, there are problems in raising public awareness for environmental pressures, possible and proposed solutions and legal measures, or how, when and who can participate in the processes of decision making and implementation of water policies. On the other hand, there are issues in collecting, processing, evaluating and sharing water related data among administrative agencies, scientific forums and stakeholder platforms, in order to create a complete and precise picture for every problem and every case. Another important aspect of policy making related to information issues that sometimes is neglected is the relative terminology. It is needed to make clear the terminology, so every term to means the same to everyone who uses it. For example, the term *"civil society"* for free-market liberalism is close to the concept of market, the adverse pole of the state, while for the pluralist and communitarian tradition the *"civil society"* expresses mutuality and voluntarism, a space between the state and the market. A third pole is that of the NGOs'. (Castro, 2007). According to Rogers & Hall, 2003, *"civil society can be considered to be composed of all general-purpose non-governmental organizations such as professional societies, labor unions, interest groups, trade groups, political parties and other freely formed clubs and associations. Of course, special-purpose interest groups are also part of civil society"*. Another example of the vagueness that sometimes exists can be the term "partnership" in the developed and developing countries. In the latter, people may have even no democratic rights of participation and control upon state or private actors related to water management, so for them this term is almost meaningless, with no practical value. (Castro, 2007)

Placing priorities issues can be originated in cultural, political, social, historical, geographical, economic and other factors, generating the matter "what is more important" for each actor, in comparison with other stressors, in order for it to be promoted and, subsequently, to be funded. Of course, once again this is also power and balance play.

Of course, the above challenges are indicative and not complete. Besides, the OECD has grouped seven main types of governance bottlenecks – or gaps, so as to be reached an effective plan and application of water policy measures, following a holistic approach on water governance (OECD, 2015 A). One major characteristic of them is that they are interconnected and the existence of one may lead to create another gap, so their study cannot be conducted separately. The first step of their analysis is, of course, the right identification of the existing gaps in each case.

Another important issue is what triggers the emergence of every gap. (OECD, 2015 A)

These multi-level governance challenges are:

- *Administrative gap*
- *Objective gap*
- *Policy gap*
- *Funding gap*
- *Capacity gap*
- *Information gap*
- *Accountability gap*
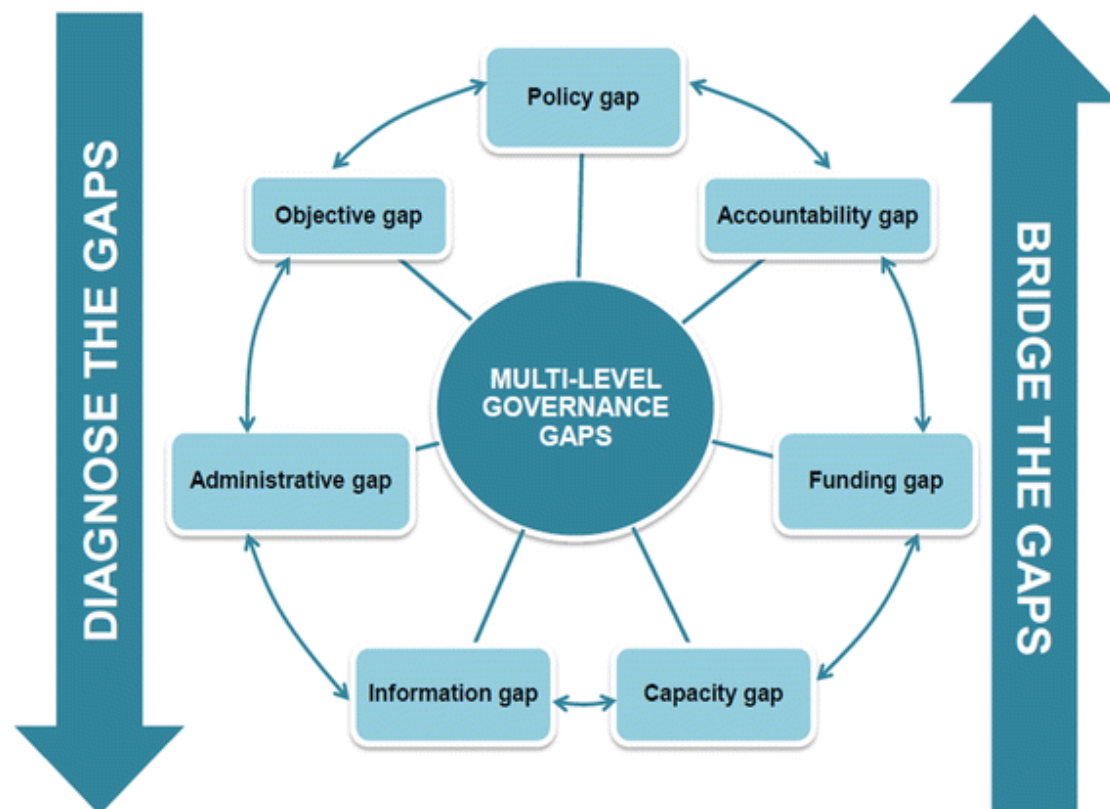
Figure 3: OECD multi-governance framework: Mind the gaps, bridge the gaps (Source: OECD, 2015A)

3.3.1. Administrative gaps – problems of scale and scalar dimensions

Administrative gaps are related to geographic incompatibility between administrative and hydrological confines, or, in other words, to scalar dimensions of governance, according to the OECD. This mismatch may affect negatively the effectiveness of water services and investments and also may enhance the

competition among users and uses, because of weak coherence and coordination, or due to the use of not the appropriate scale. It is important to track the connections between urban and rural areas that support them. (OECD, 2015 A)

Figure 5.2. **Scalar dimensions of water governance in cities**
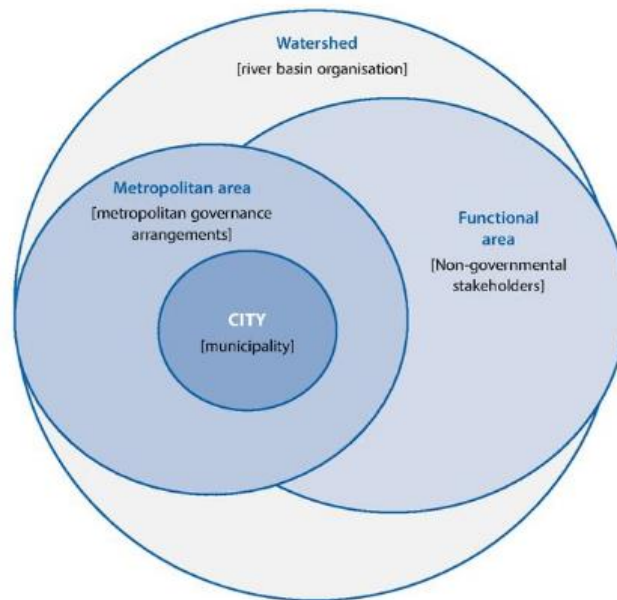
Figure 4: Scalar dimensions of water governance in cities (Source: OECD, 2015A)

These also raise the question about problems of scale and dimensions of scalar politics in water management (Moss & Newig, 2010). Despite the universal need for common norms and action coherence that, theoretically, is ensured by a multi- level governance at the global level, the motivation and needs of every country and stakeholder, regarding scaling up or down on water-related issues, variates, so we speak for ''*politics of scale''.* (Gupta & Pahl-Wostl, 2013)

Although the terms ''scale'' and ''level'' are widely used in water governance literature, they do not have the exact same meaning. Actually, in the academic community, there is sometimes a distinction between these terms. For Cash and others, cited in (Moss & Newig, 2010, ''scale'' indicates dimensions (for example biophysical-hydrological and institutional), whereas ''level'' signifies a (vertical) step in the hierarchy of a ''scale''.
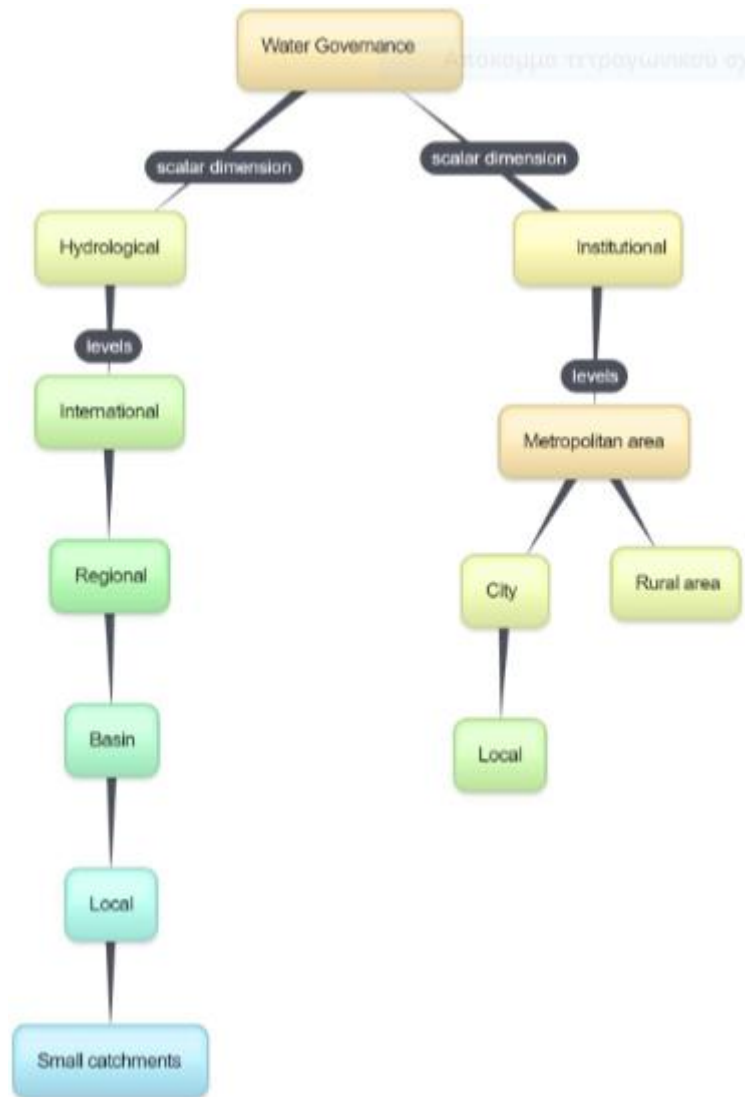
Figure 5: Example of scales and levels in water governance

Problems of scale in environmental science include, according to Moss & Newig, 2010:

- *Problems of scalar fit* among different scalar dimensions
- *Problems of* finding the *optimal scalar level* to meet desired objectives
- *Problems of vertical interplay* among different levels on one scalar dimension
- *Problems of rescaling* of levels in case of rearrangement
- *Problems of valid upscaling and downscaling* in knowledge generalization from one level to another

According to Moss & Newig, 2010, there are three main scalar dimensions in water governance. These are related to:

- Political perspective: legitimacy in a democratic context can be either *input-oriented* or *output-oriented*. The former is a result of the operation of the

higher levels of governance, which implies lower possibility for citizen participation and, thus, potential difficulty in acceptance and performance of decisions taken and the latter the lower levels of governance, which may lead to reduced effectiveness of policy making, especially for non-only local problems. In other words, there is a matter of balance between public participation and policy effectiveness (Dahl, 1994, cited in Moss & Newig, 2010), the attempted fulfilment of which is maybe one significant reason for both the complexity in the current levels of governance and the scholarly encouragement in *highly polycentric and multilevel systems* (Ostrom, 1999; Armitage, 2008, cited in Moss & Newig, 2010). In parallel, researchers call into question the nested hierarchies' effectiveness in implementation of policy measures (Pressman et al., 1984; Tsebelis, 1995, cited in Moss &Newig, 2010).

- Economic perspective: one important question is about the way in which revenues and expenditures can be distributed properly in different levels of water governance.

- Human geography perspective or social perspective: From this point of view, scale is a *''medium, an object and a product of social conflicts and negotiations''* (Brenner, 2004 and others cited in Moss & Newig, 2010) and it is considered as a dynamic situation of gaining or losing power among stakeholders during and because of spatial reconfiguration procedures. Thus, equity matters emerge.

Therefore, the critical question is *''which water problems at which level?''*

There has been much debate about the domination of which level as the most appropriate for water governance, or to put it differently, which is the right degree of hierarchical and centralized perspective on water governance, as global water challenges push for higher levels of governance, while the subsidiarity principle for example, demands control at the lowest possible level. (Gupta & Pahl-Wostl, 2013). As Gupta & Pahl-Wostl, 2013 claim, multi-level governance seems to be the most preferable approach towards sustainable water management. However, it is also detected that researchers of different scientific fields promote their faculty as most appropriate scale for adoption. For instance, hydrologists propose the river basin scale, when political scientists promote the national-state one (Bakker & Morinville, 2013).

In addition, it must be pointed out that it is not wise, productive or even effective all the decision-making processes to be allocated on many scales or on non-state agents. (Bakker & Morinville, 2013). It is important for the governance to still have its role as an overall organizer and supervisor with centralized government, controlling key functions (Bakker & Morinville, 2013; Gain, Rouillard, & Benson, 2013).

In order to decide which the optimal level is in any given case the general social, economic, geographical, hydrological circumstances and linkages must be taking into account, along with the evaluation of the performance of every scale and level of governance (Bakker & Morinville, 2013).

3.3.2. Objective gaps

Objective gaps can be a product of clashing water-related interests within a given area or political discontinuity, which may lead to disagreeing goals that jeopardize long-term integrated water policy targets.

According to a study conducted by the OECD, the most important challenges, which the responders consider that erode the long-term operation of water management are (OECD, 2015 A, Fig. 5.3.):

- dissensions among levels of governance
- lack of institutional inducements for collaboration
- competition among local authorities
- interventions of political interest groups (lobbies)
- conflicts among water users and uses

Therefore, it is obvious that governance is a fundamental parameter to ensure alignment of interests. (OECD, 2015 A)

Specialized water literature sometimes seems to try to depoliticize water management procedures, consider them mostly as *''technical'' or ''objective and neutral'',* when they are basically a political expression, according to an alternative viewpoint (Castro, 2007). As follows from the above, confrontations of social and political factors, which are driven by different objectives, are essential part of water governance procedures. Thus, the need for coordination among different fields of expertise is once again evidently necessary. (Castro, 2007)

3.3.3. Policy gaps

Policy gaps are connected to the fragmented character of water management. This fragmentation is the result of the institutional authority of many different agencies upon water related matters, at vertical and horizontal level. For instance, in many countries, there are several ministries charged to address strands of water issues, such as environmental ministry, health ministry, economics and finance ministries, while multi-level governance from sub-national to supra-national levels regulates water and wastewater services. (OECD, 2015 A)

Unclear roles and vague or overlapping responsibilities, as well as poor co-ordination among these governmental actors involved reduce coherence and lessen the

possibility of strong and effective water governance, as the OECD surveys have indicated. (OECD, 2015 A)

In the 90's-00's, scientists and policy makers have recognized the need of water governance at the global level, while it became prominent in many cases the ineffectiveness of current governance models, regarding the alarming pressures that have already been mentioned (climate change, unsustainable water use, population growth, users' frictions, environmental degradation and others), many of which are not directly originating from water sector. Taking this into consideration, there is a clear-cut need for cooperation among different fields of policy, that have been considered unconnected with one another and with water sector so far, for example, inter alia, agriculture, energy, trade, land use, solid waste management, and transportation (Pahl-Wostl, Conca et al., 2013; OECD, 2015 A)
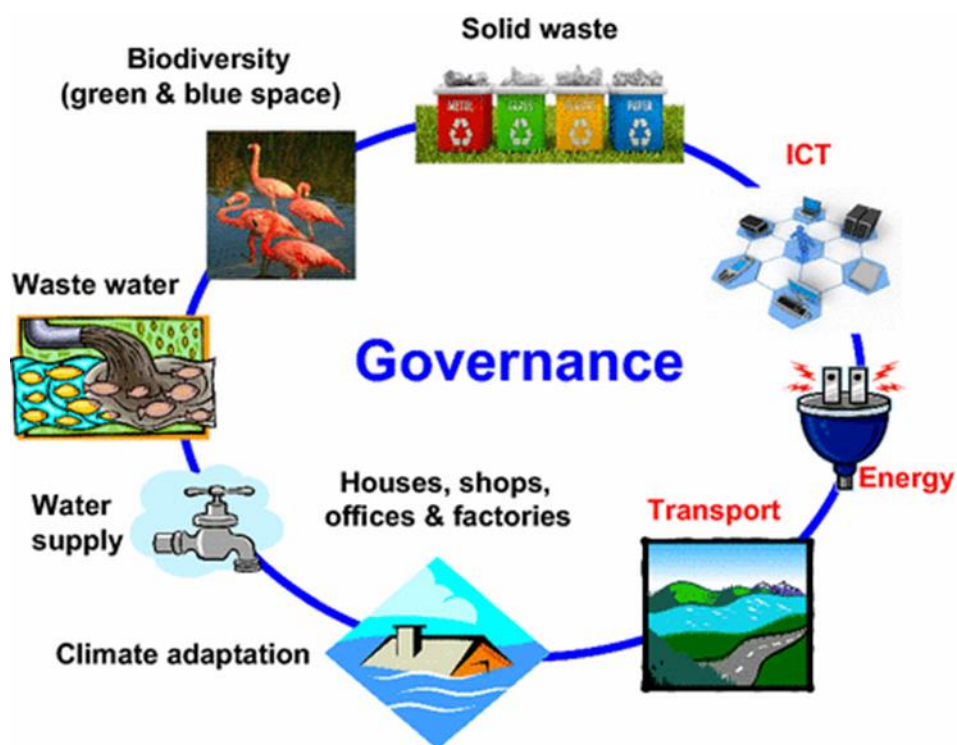
Figure 6: Simplification of a smart city, according to EU (Source: Koop & Van Leeuwen, 2016)

Figure 6 depicts the simplification of the EU's vision for a smart city, which will be discussed later (European Commission 2013, cited in Koop & Van Leeuwen, 2016). As it can be noticed, transportation, energy, ICT (information and communication technology) and solid and water waste are integrated in the city's governance.

3.3.4. Funding gaps

Funding gaps can happen as a consequence of disputable resource distribution, uneven financial management and lacking or changeable revenues, situation that

might put at stake efficient implementation of water policy, as well as relevant investments, at the sub-national level. (OECD, 2015 A; OECD, 2018).

Among the reasons that cause these funding gaps are, according to OECD research, the following (OECD, 2015 A, Fig. 5.5.):

- difficulties in raising tariffs for water services
- affordability issues that require tariff adaption
- difficulties in placing investment priorities
- difficulties in receiving water charges and tariffs
- lack of financial guarantee for the city
- lack of long-term strategic vision and budget
- fiscal power and taxation with limited decentralization
- difficulties in private sector activation for financial investments

Relating to the above, it is worth mentioning that the degree of decentralization of a country is also revealed by the role of central government in tariff-settings. (OECD, 2015 A)

3.3.5. Capacity gaps

*Capacity gap*s originate in the narrow financial, scientific and technical potential of local players which is possible to provoke deficient policy making and implementation, apart from information and accountability challenges. (OECD, 2015 A)

Among the sources of these capacity gaps may be, according to OECD research, the following (OECD, 2015 A, Fig. 5.7.):

- lack of personnel and managerial competence
- difficulties in monitoring and assessing procedures
- difficulties in previsioning
- lacking planning
- limited knowledge for water

3.3.6. Information gaps

At present, necessary knowledge and information related to water issues are more often than not produced by studies of different sectors and perspectives, which usually lead to fragmentation, as well as to difficulties in access, understanding and participation of various stakeholders. (Providoli et al., 2017)

Information gaps are caused by the procedure of collecting data- what, when, how and who. Collecting, sharing and producing credible information is varying across cities. One important reason for this is that the data collection might be conducted by many different sources, such as local agencies, service providers or statistical

offices. Consequently, the produced data may be deficient, inconsistent, uneven, scattered, depended, or even too technical to be understood by ordinary people. Information asymmetries might stir up sub-optimal solutions and arrangements, public distrust, as well as decreased accountability, transparency and public interest protection. (OECD, 2015 A)

Science and technology are instruments of primary importance for the proper collection, verification, analysis, dissemination and feedback of information. (Providoli et al., 2017). It is also evident, that the impressive technological and scientific development in water related sciences has not brought more efficient and sustainable processes on water management, as the growth of interdisciplinary approaches on water governance are needed as well, to enhance the contribution of technology. (Castro, 2007). In addition, in many cases the technical solutions for water problems have already been developed, and the only obstacle in their actualization is the policy framework (OECD, 2018).

Examples of systems for data's collection are the web-based, publicly accessible to every interest actor platforms, such as:

- The European Environmental Agency (EEA) is an EU agency, established in 1990 and located in Copenhagen, with the membership of EU countries, Norway, Iceland, Liechtenstein, Switzerland & Turkey. Main objective of this agency is to be a considerable information provider for EU institutions, participant governments, scientific and academic associations, NGO's, business groups, consultancies and think tasks and general public, in every stage of policy-making, from conceptualizing to implementing and evaluating a sustainable strategy framework. A network named Eionet, is composed of national environmental organizations developed and coordinated by EEA. The Eionet Portal (https://www.eionet.europa.eu/) is a website for collecting and sharing of information and data related to environment and environmental management (https://europa.eu/european-union/about-eu/agencies/eea_en , https://www.eionet.europa.eu/)
- The Water and Land Resource Information System in Ethiopia (http://walris.wlrc-). (Providoli et al., 2017)
- Socio-hydrological Information and Knowledge Platform in Kenya (http://wlrc-ken.org/). (Providoli et al., 2017)

With solid, current and valid information, the policy steps in which it is translated into become more tailor-made, precise, adequate and effective and also foster learning of the best of other practices. (Providoli et al., 2017)

Nevertheless, as regards web-based networks, as communication platforms across multi-stakeholders, they have proved to be insufficient as an autonomous

instrument in some cases (for instance in south-west Virginia, Australia), without the contribution of *face-to-face dialogue* and interaction. (Neef, 2009)

3.3.7. Accountability gaps

Accountability gaps are connected to transparency issues in policy making and implementation that may influence participation, deliberation and engagement. (OECD, 2015 A)*.* These issues are mostly connected to debilities in steady implementation, assess and monitoring of water policies (OECD, 2018).

In more detail, according to OECD research some of the factors that affect accountability and transparency in urban management of water resources are (OECD, 2015 A, Fig. 5.9.):

- difficulties in sharing data among local authorities
- feeble stakeholder involvement
- weak benchmarking
- lack of publicly accessible economic data
- difficulties in conflict resolution due to judicial system weakness
- lack of competitive processes in procurement
- lack of publicly accessible drinking water quality data
- lack of regular financial audits

In order to evaluate the performance of urban water management and to ensure accountability and transparency benchmarking, financial analysis and national observatories are needed. (OECD, 2015 A)

3.4. Achieving good governance

3.4.1. Good governance principles

As it has been discussed in the previous sub-chapter, there is a variety of challenges and factors that lessen the effective and productive water governance, leading to poor governance issues, with the ensuing negative repercussions in water related problems solving and in economic and social activity, prosperity and security as well. As a result, good governance is of primary importance for social, economic, environmental, political and institutional stability, sustainability and development (Rogers & Hall, 2003).

Due to the fact that every country or specific area deal with different kinds of problems in a given general framework, it is appropriate the proposed alterations, in order to ameliorate governance practices, to be specialized and context based. There is no ''*one-fits-all*'' or ideal governance structure for any existing challenge in any country (OECD, 2018). For example, it is not realistic to expect that developing

countries, which mostly have rigid hierarchical governance structures, is good or even possible to adopt the same strategies and structures as developed countries that have developed more distributed and flexible governance frameworks, let alone the rest of the discrepancies (Rogers & Hall, 2003). Nevertheless, there are some general fundamental principles which are essential components of a good governance system in practice and what is expected is every country to adjust them in its particular context, in a feasible and practical way. What is also important is to learning from other cases without just rashly following suit them. (Rogers & Hall, 2003)

Many relevant researchers, authors and organizations consider a variety of good governance elements. Among these vital principles that are preconditions for good governance are (Rogers & Hall, 2003; OECD, 2018; Biswas and Tortajadaas cited in Gain, Rouillard, & Benson, 2013):

- *inclusiveness*
- *accountability*
- *participation*
- *transparency and openness*
- *predictability*
- *responsiveness*
- *legitimacy*
- *human rights*
- *rule of law*
- *decentralized decision-making* (Although for other authors, for instance (Rogers & Hall, 2003), there is no proof that more decentralized structures are inevitably more effective than centralized ones and is more a matter of what is appropriate for each case. Many studies have indicated that effective governance structures have been balanced between *bottom-up and top-down approaches,* with special regard to the linkages among levels. (Huntjens et al., 2010; Pahl-Wostl et al., 2012, cited in Guptra & Paul-Wostl, 2013)
- *problem-solving approach*

Apart from the above general directional principles, similar concepts with variations have also been developed, including policy frameworks, international and European agreements and legislation.

For example, Rogers & Hall, 2003 make the following distinction in the principles for effective governance, regarding approaches as well as performance and operations:

- ❖ *Approach*:
  - *open and transparent* institutional processes to the general public
  - *Inclusive and communicative* in every stage of policy making

- - *coherent and integrative* actions taken of every relate field
  - *equitable and ethical* for all interested actors in every stage of policy making and implementation
- ❖ *Performance and operations:*
  - *Accountable* in every part of policy cycle and actor involved
  - *Efficient* in economic, social, political and environmental terms
  - *Responsive and sustainable* evaluating past, current and future performance targets

In addition, according to OECD studies, in order to bridge the previous mentioned gaps that generate poor governance conditions, the focus should be given on three governance arrangements: *metropolitan governance, dedicated water regulatory bodies and stakeholder engagement.* (OECD, 2015 A)

- ❖ *Metropolitan governance* is necessary to be build, given the actual pressing challenges regarding environmental and financial issues, in order to enhance sustainability and inclusiveness. The OECD research propose four categories of governance arrangements: (OECD, 2015 A)
  - *Informal/soft co-ordination,* consisting of data-exchanging and consulting platforms with low degree of institutionalism
  - *Inter-municipal authorities*, aiming to share duties and costs throughout member-municipalities
  - *Supra-municipal authorities*, created either as a directly-elected metropolitan government or as a non-elected metropolitan body placing by upper government, having responsibilities on behalf of the municipality for given water concerns
  - *Metropolitan cities*, cities with population larger than a defined limit, having broader responsibilities in water policy-making and services provisioning, which is equal to that of the next upper government level

Metropolitan structures' competencies include, among others, provision of strategy planning, technical expertise, legislation and regulation, distribution of funding, information sharing etc., offering models that facilitate policy continuity, co-operation among actors and promoting integrated urban water management in general. (OECD, 2015 A)

- ❖ *Dedicated water regulatory bodies* have been established in many countries so far, charged to operational and regulatory functions upon urban water services, in order to protect public interest, cooperating with other upper and lower water-related agencies. (OECD, 2015 A)

  In more detail, these structures basically support the according operations: (OECD, 2015 A)

  - *economic regulation,* including tariff-setting and investment plans
  - *data collection and water services performance control*

- *standards and regulation implementation*
- *customer commitment and protection*

❖ *Stakeholder engagement* has a vital role to play in the successful planning, enforcement and performance of integrated water management plans as can contribute, inter alia, to raise and maintain (OECD, 2015 A):
  - public awareness on water challenges
  - trust and ownership
  - willingness to pay
  - accountability and transparency
  - political acceptability
  - commonly accepted objectives

Stakeholder participation can be possible by the use either of web-based technologies such as online platforms, social media, websites, apps, or conventional media, for example TV, newspapers, newsletters, along with regular meetings. (OECD, 2015 A). However, multi-stakeholder platforms (MSPs) sometimes not fully fulfill their intercessory role. An important cause for that is that often the powerful stakeholders do not want to share their influence, fact that decreases the possibility for real action and also induces disappointment to the participants because of great expectations and actual performance of MSPs (Bakker & Morinville, 2013).

The most common difficulties in the wide and productive stakeholder participation are, among others, the complicated nature of the water issues, the reluctance to change, the fragmented or weak knowledge, the lack of water concern, the over-represented stakeholder categories, the weak legal and financial framework, the lack of time and the lack of feedback and clearness. (OECD, 2015 A)

Despite the fact that there is an evident shift from a command-and-control natural resources management to a more participatory approach, worldwide, also known as *participatory environmental governance*, based on collaboration and deliberation among stakeholders and policy-makers which is encouraged by international voices, such as Rio Declaration, which will be further presented accordingly, critiques are not missing. (Neef, 2009)

Many socio-political scientists consider public participation as a ''*contested concept*'' that misjudges both the complex dynamic of local communities and the anticipated profits of the empowerment from lower levels regarding decision-making. Other scholars go even further, talking about for a ''*new tyranny of participation*'' (Cooke and Kothari, 2001, cited in Neef, 2009).

It appears that these critiques concern different aspects of stakeholder participation in water governance of both urban and rural areas. For

example, it is pointed out the risk of power and equity unbalance consolidation, as the focus remains on technical solutions rather than on giving power to marginalized actors, in a ''*symbolic form of democratic participation*''. A higher degree of institutionalization and representativeness lead to, according to (Batterrbury and Fernando, 2006 and others cited in Neef, 2009), more sustainable types of local participation, despite the fact that, sometimes, local stakeholders better prefer informal arrangements rather than more formal participation, which might lead to ''fatigue'' and ''pseudo-democratic'' public engagement. (Parker, Moore and Weaver case studies cited in (Neef, 2009)).

Another instrumental factor that should not be ignored in the analysis of participatory approach is the cultural and sociopolitical background of each case, for example developing and developed countries, which have different social and institutional structure, political operation, historical precedent, as it has been pointed out before. It has been proved by researches that people tent to embrace new rules that are in harmony with their own customs. In the light of this remark, it is rational the finding of a (Parker, Moore and Weaver case studies cited in Neef, 2009), saying that multi-actors settings are successful, regarding local interests and resource management compromise, when they are based on actual social networks and shared purpose. According to (Folk, Bock and Kirkas cited in Neef, 2009), ''*the success of polycentric governance-as expressed in more efficient water use-then depends on the right mix of statutory and customary enforcement mechanisms*'', which also expresses the same perception.

Neef, 2009 also points out the dipole which is created sometimes by technocrats and policy-makers, on the one hand, and NGOs on the other, regarding the capacity of local communities to participate purposefully in governance, indicating that way the degree of decentralization. The first group questions the ability of local actors' contribution in viable decision-making, fortifying central authorities, while the latter considers them as suitable to solve water-related problems, as they share common rules and ethics. (Neef, 2009). As in almost everything, the truth must be somewhere in the middle. It is logically inferred that local authorities and communities may actually have better knowledge of local affairs and the state of play, being sometimes bypassed by higher level of governance or by the most powerful actors (Rogers & Hall, 2003). However, local control is not imperatively positive and how and why rescaling processes actually empower the local community, as it has been verified the opposite, for example the *case of rescaling Canada-USA transboundary resources to the local scale* (Norman and Bakker study cited in Bakker & Morinville, 2013). Therefore, it is also important to control the validity, knowledge and the overriding objective of every actor who wants to enter into the water governance processes.

Central governments have a vital role in the promotion and facilitation of the fair and effective stakeholder participation. Although Dublin Statement and others firmly support participatory framework in water management, they provide little counseling on the way that it is possible for it to be achieved, especially in cases that exceed regional or even national boundaries. (Neef, 2009). The OECD, working on this direction, has launched a set of principles for effective stakeholder engagement in water decision making issues. These principles are (OECD, 2015 A, box 5.3):

- *inclusiveness and equity*: a stakeholder analysis will offer an overview of the identity, motivation, interaction and the potential role of every affected actor
- *clarity, transparency and accountability*: a defined decision making line, stakeholder objectives and expected input phase, with the provision of all data needed combat any possible political short-termism and enhance clear actions
- *capacity and information*: proper distribution of human and financial resources along with information shared in understandable way, education and total participation help maintain motivation, action and interaction
- *efficiency and effectiveness*: regular evaluation of stakeholder participation enables learning, adjustment and improvement of processes
- *institutionalization, structuring and integration*: clear legal and policy outlines and relative authorities in charge
- *adaptation*: tailor the level and form of stakeholder involvement according to the changing conditions

3.4.2. The OECD Principles on Water Governance

The OECD Principles on Water Governance address water uses (for example domestic, agriculture, industry), water management aspects (for example drinking water supply, sanitation, water quality and quantity, flood control), as well as ownership of water resources and assets (for example public, private and mixed) in an integrated, undivided manner.

The three dimensions of water governance in which OECD Principles are grouped are (OECD, 2015 B):

- *Effectiveness*, in order to set, implement and fulfill sustainable water policy objectives at different government levels
- *Efficiency*, in order to optimize the sustainable water management benefits *at the least cost to society*

- *Trust and engagement,* in order to strengthen public confidence and stakeholders' inclusiveness through democratic, legitimate and fair procedures

Figure 7: OECD Principles on Water Governance (Source: OECD, 2015B)

The *OECD Principles on Water Governance* were adopted in May 2015 by the OECD Regional Development Policy Committee and they are based on good governance principles. They are (OECD, 2018):

1. *Clearly allocate and distinguish roles and responsibilities for water policy making, policy implementation, operational management and regulation, and foster co-ordination across these responsible authorities*
2. *Manage water at the appropriate scale(s) within integrated basin governance systems to reflect local conditions and foster co-ordination between the different scales*
3. *Encourage policy coherence through effective cross-sectoral co-ordination, especially between policies for water and the environment, health, energy, agriculture, industry, spatial planning and land use*
4. *Adapt the level of capacity of responsible authorities to the complexity of water challenges to be met and to set of competencies required to carry out their duties*

5. *Produce, update and share timely, consistent, comparable and policy-relevant water and water-related data and information and use it to guide, assess and improve water policy*
6. *Ensure that governance arrangements help mobilize water finance and allocate financial resources in an efficient, transparent and timely manner*
7. *Ensure that sound water management regulatory frameworks are effectively implemented and enforced in pursuit of the public interest*
8. *Promote the adoption and implementation of innovative water governance practices across responsible authorities, levels of government and relevant stakeholders*
9. *Mainstream integrity and transparency practices across water policies, water institutions and water governance frameworks for greater accountability and trust in decision making*
10. *Promote stakeholder engagement for informed and outcome-oriented contributions to water policy design and implementation*
11. *Encourage water governance frameworks that help manage trade-offs across water users, rural and urban areas and generations*
12. *Promote regular monitoring and evaluation of water policy and governance where appropriate, share the results with the public and make adjustments when needed.*

These Principles that embrace all the components of good governance are proposed to be used or have already been used in order to achieve many goals in the long way of policy making from conception to enforcement, for instance as guide for policy makers and practitioners, for research purposes and other types of relative evaluation and analysis (OECD, 2018).

In addition, these Principles are based on the perception that water governance is ''*a means to an end rather than an end in itself*'' (OECD, 2018), seeing again that instrumental view of governance.

As a guide, one may support that the OECD Principles on Water Governance offer a comprehensive yet visionary framework, which incorporates all the necessary prerequisites for sustainable and effective water governance, with provision for the future, in terms of both future generations needs address and continuity of policy measures. Of course, in order to be succeeded something concrete and real, a throughout analytical and theoretical framework and plan is always required to be followed.

In order to put into practice the above set of principles, the OECD have developed a framework for action, the ''OECD water governance indicator framework''.

3.4.3. The OECD water governance indicator framework

The OECD water governance indicator framework is developed as a self-assessment support tool for the better enforcement of the OECD Principles on Water Governance, for improved reforming of water policy measures. (OECD, 2015 B)

The OECD water governance indicator framework consists of a *Traffic light system* of 36 indicators of water governance, 3 for each principle, a *Checklist* of 100+ questions and the resulting *Action Plan* for further discussion upon future amelioration. It is based on multi-stakeholder point of view, it can be applied on every governance scale and water management aspect and it is proposed to be used provided that transparency, impartiality, openness, trust and insightfulness are assured. Due to the fact that it is difficult to count every possible parameter in water related problems, these indicators touch upon basic lines and they can be used as a first exploration in every case's special needs and conditions. (OECD, 2015 B)

Participators in the procedures proposed by this framework can be key stakeholders, such as (OECD, 2015 B, Fig):

- *users, for example domestic, industry, irrigators*
- *policy actors, for example regulators, supranational bodies, national, regional, local authorities, watershed institutions*
- *operators, services providers and relative associations*
- *influential and interest groups, for example civil society, consumer associations, trade unions, scientific and academic groups, media*
- *financial factors, for example financial institutions, donors*
- *unrepresented actors, for example women, youth, poor, indigenous, subsistence farmers*
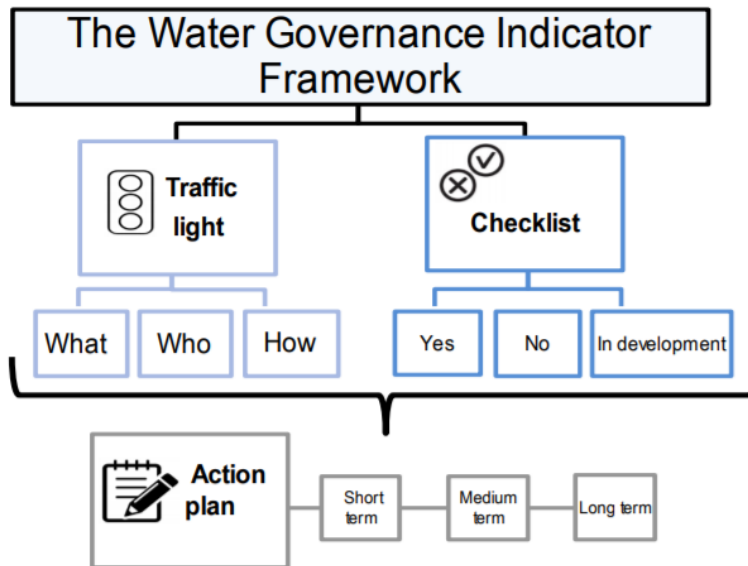
Figure 8: The Water Governance Indicator Framework (Source: OECD, 2015B)
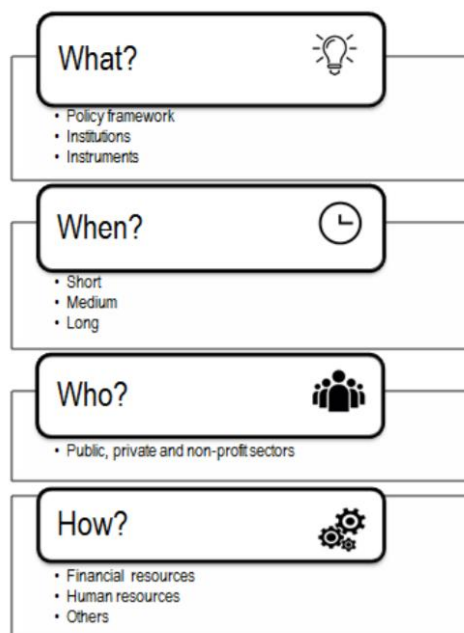
Figure 9: The Action Plan concept (Source: OECD, 2015B

A 10 step (self-) assessment methodology of the performance of a water governance system assists the self-assessment, in order to identifying the limitations and the positive points, guiding the decision making and implementation processes. The steps suggested are (OECD, 2015 B):

1. *Check roles and responsibilities of the lead institution*
2. *Understand the principles and indicators framework*
3. *Set objectives and scope of the assessment*

4. *Map stakeholder and their core motivations*
5. *Appoint an independent and trusted facilitator*
6. *Agree on the rules of the procedure*
7. *Organize the multi-stakeholder workshops to assess the water governance system against the traffic light and the checklist, and design the Action Plan*
8. *Link actions with the existing policy framework, strategies and plans*
9. *Set up an accountability process to track progress over time and keep the dialogue alive*
10. *Consider repeating the self-assessment every three years*
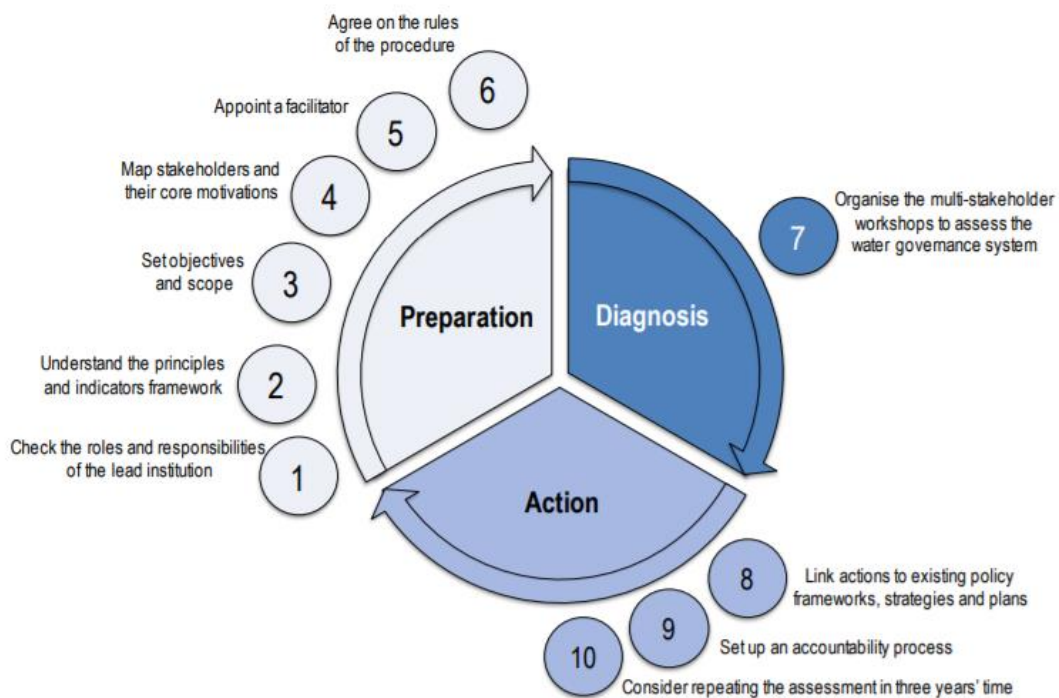
Figure 10: The ten-step assessment framework (Source: OECD, 2015B)

As it has been referred, the OECD Water Governance Indicator Framework aims to ameliorate water governance practices in the current and future timeline. A crucial step in every attempt of change is the monitoring and evaluation of the steps that have already been done, based on the principles and indicators, in an infinite cycle of implementing, learning and adjusting, as it is presented in the following picture.
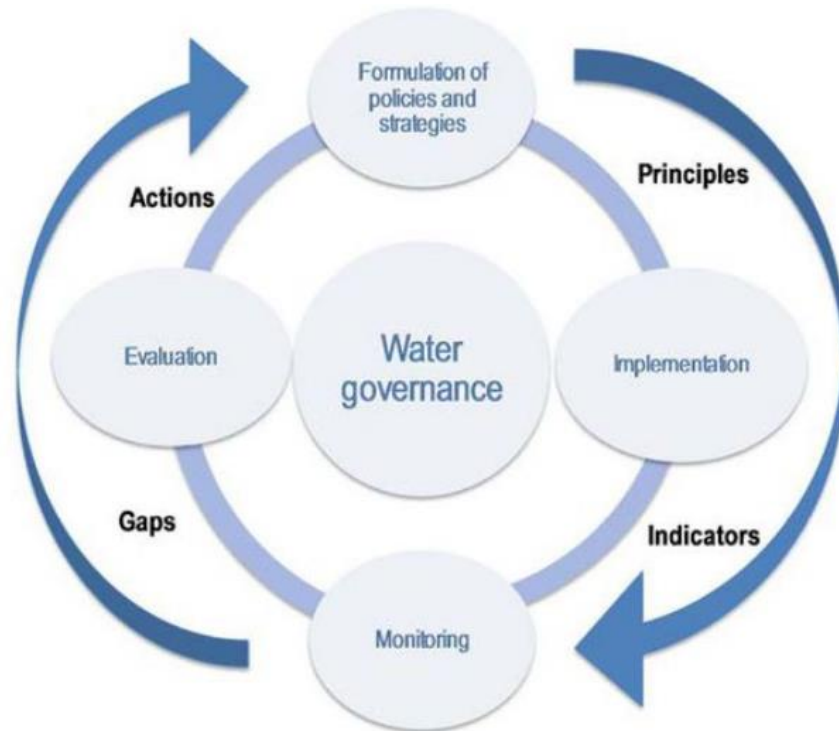
Figure 11: The water governance policy cycle (Source: OECD, 2018)

3.4.4. Water related legislation and agreements' framework

Plethora of countries in the world are being designed new legislation and strategies for sustainable water management, after debates about water governance (World Water Council, 2003), as a response to the need for good and effective governance at a local, national and international level.

Internationally, in Europe, Australia and North America have been developed sustainable strategies for water. Among the most prominent and influential water policy frameworks are the Dublin-Rio Principles and the European Water Framework Directive that provides a conceptual guide for integrated water planning. Additionally, among other international agreements are the Sustainable Development Goals, the New Urban Agenda, the Paris Climate Agreement and the Sendai Framework for Disaster Risk Reduction 2015-2030. These agreements are fruit of the urgent need to address multiple challenges and governance is essential part of their actualization.

It is not also unusual the design and adoption of water law at a local level, for example cities as Amsterdam, Melbourne and Hamburg, which have created adequate water governance at local level (Koop & Van Leeuwen, 2016)

The International Conference on Water and the Environment (Dublin,31/01/1992), in which have participated five hundred representatives of governments and international, intergovernmental and governmental organizations, recognizing the present situation with regard to water and its importance for the future conditions, adopted a set of recommendations for local, national and international organized action. (http://www.un-documents.net/h2o-dub.htm)

The base line of the Dublin proposals is defined in the next four guiding principles (http://www.un-documents.net/h2o-dub.htm,
https://www.gwp.org/contentassets/05190d0c938f47d1b254d6606ec6bb04/dublin-rio-principles.pdf Dublin Rio Principles, Global Water Partnership, http://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html#principles):

- Principle 1: *Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.*

  As the preciousness of water is given and linked with every part of human activity, the need for a holistic and coordinated management of natural, economic, political and social systems, in every level, is a demand and a challenge at the same time.

- Principle 2: *Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels*
  As water is a shared concern, everyone is a stakeholder. Participatory approach is evident when all stakeholders-even the marginalized ones-play a role, given and protected from government, in the decision-making process, so as to be guaranteed, as far as possible, that there are not predetermined decisions or a dominant interested group. Participation takes different forms according to the special case conditions and it is a key determinant of long-term general acceptance and agreement.

- Principle 3*: Women play a central part in the provision, management and safeguarding of water*
  Women are strongly involved in providing and using water for, mainly, domestic and agricultural activities, but, in many cases, they do not have the opportunity to take part in the decision-making process, the results of which may affect women and men differently. In order to succeed equal rights between women and men, action must be taken for the empowerment of woman's position and participation in every stage of water policy program development.

- Principle 4*: Water has an economic value in all its competing uses and should be recognized as an economic good*
  Accessible clean water and sanitation in a reasonable cost is a fundamental human right. Nevertheless, water value and charges for water-connected services express different angle of water management. Recognition of the value of water in alternative uses foster sensible water distribution, while water charges contribute to efficient and equitable usage, incentives' provision, cost recovery and also reflect users' willingness to pay for water services.

3.4.4.2. Brief EU Water legislation review

One of the main fields for action that are covered by EU environment policies is water, recognizing that way the growing stress in water quality and quantity.

For better analysis, it is separated in seven categories, as follows: river basin management, flood risk management, water scarcity and floods, drinking water, bathing water, emissions and water reuse, adaptation to global change. Directives that are related to the above categories are: Water Framework Directive (for river basin management), Floods Directive (for water scarcity and floods), Drinking Water Directive, Bathing Water Directive, Urban Waste Water Directive (for emissions), Ground Water Directive, Environmental Quality Standards Directive (or Priority Substances Directive).

Due to the fact that the Water Framework Directive is characterized as the most comprehensive EU water strategy's tool, the focus will be given on it. The ''Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy'', as it is the full title of EU Water Framework Directive (WFD), became effective on 22 December 2000. EU countries had to raise it into national legislation within three years. According to this, water must be treated as a heritage and not as a commercial good.

The head goal of this directive might be considered the maintenance of a good status (ecological and chemical) for EU waters (lakes, rivers, groundwaters, transitional and coastal waters) by a set deadline, based on integrated water management in river basin level, with sustainable water usage, *''combined approach''*, right pricing, active stakeholders' participation and streamlining legislation. Particularly:

- River basin level (hydrological and geographical unit) is deemed as the proper level of water management, instead of political or administrative borders. As a river basin may reach across different counties, management plans need to be coordinated and revised every six years.

- Integration approach is an essential element in order to meet water protection objectives, by phasing the application of all measures taken. Integration, except for water sector, also includes interlinked sectors as energy, transportation, agriculture, fisheries, tourism.

- As *combined approach* to pollution control is defined the attainment of coordination between source controls and quality standards.

- A river basin management plan contains, inter alia, river basin's traits, human activity's repercussions on water, measurement of existing policies' effectiveness, further actions required to increase effectiveness, economic analysis of basin's water uses, cost-benefit analysis for every possible action.

- Public participation is of primary importance for both complete and accurate design of and acceptance and compliance with the water management plan, strengthening justice, transparency and balance among affected parties. In order for the public participation to be guaranteed and the procedures to be well implemented, a conference every two years and a network provide the necessary platforms for proper information and experience exchange among countries, expert groups, various stakeholders and interested people. For example, ''Communication and Information Resource Centre for Administrations, Businesses and Citizens'' or CIRCABC is a web-based service of European Commission created to contribute to the above purpose.

- Water pricing, when it is adequate and corresponds to the real water cost, is regarded as key to the success of water management aims, motivating sustainable resources' use.

- Different conditions demand diverse action, so every solution proposed need to be suitable for the specific case, with long-term vision.

- Effectiveness, transparency, coherency must characterize the action framework, along with subsidiarity.

- Monitoring programs and controls of surface water, groundwater and protected areas' status is necessary to be established by state-members, for providing a coherent overview of each river basin waters.

- Incentives for efficient water use reflected on water-pricing policies and adequate water allocation in households, agriculture and industry may be included in the cost recovery principle (recovery for water services costs) application.

- Co-operation between member-states when a relative problem emerges becomes possible through a Commission process.

- Dissuasive, effective and proportionate sentences are provided for member-states' legislation in case of violation of the relative national provisions.

(http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm,
http://ec.europa.eu/environment/water/water-framework/index_en.html,
http://ec.europa.eu/environment/water/water-framework/iep/index_en.htm,
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32000L0060)

3.4.5. Concluding

Water governance is an essential part of governance of each state and more often than both have the same legal, administrative, social, cultural and economic foundation. However, the importance and the delicacy of the water sector, sometimes exceeding the national borders and becoming international concern, demand concerted action for change. Of course, as the backdrop is different and the reach of an equilibrium among common targets, economic profits and natural protection is an arduous task, there is no a magic or ideal system or recite to be followed by everyone. Instead, guidelines have been developed, that must be adjusted in the existing context. Generally speaking, there is broadly agreed that an effective water governance is good to be based on an holistic, open, flexible and participative structure, trying not to inexcusably increase transaction costs and not to hinder action (Rogers & Hall, 2003; Gain, Rouillard, & Benson, 2013).

Change and amelioration are always easier said than done, not to mention that the enforcement and alignment of water policies is always an ongoing challenge for the countries (OECD, 2018). As a result, there is a constant need for political determination and public awareness, commitment and participation, so as to solve conflicts and move on. Respect on human rights, proper financial allocation, personal and collective action, fairness in rights and obligations, trust, accountability and transparency must be the cornerstone of every attempt to better water governance structures and performance, without idealizing civil society, participation, state and the other actors and connection involved (Castro, 2007)).

4. Towards water sensitive cities

As it has been mentioned before, the realization of the importance of environmental degradation, climate change and the related uncertainties has brought about changes in the perception and practice of water management and governance, especially in urban areas. It is now widely accepted that there is a need for a paradigm shift in urban planning, which demands holistic and interdisciplinary approach, in order to actualize sustainability in city areas, following their specific background (Wong & Brown, 2009). As Wong & Brown, 2009 support, a water sensitive city is a consequential fundament towards a sustainable city. In fact, sustainable, resilient, safe and inclusive cities are the Goal 11 of United Nations (https://www.un.org/sustainabledevelopment/cities/), expressing this way the importance of that objective.

In general terms, problems trigger action, which can be achieved by relevant investments. Such is the case in here, but, as (Wong & Brown, 2009) point out, sometimes the investments are provided for the existing infrastructure and commonly-held approach, which has also been proved inadequate to respond to future challenges and needs (Ashley et al. 2003, 2005, and others, cited in Wong & Brown, 2009), generating delay in the progress toward more sustainable management. A main reason for that is the institutional and infrastructure disintegration, which has even led to *philosophical compartmentalization* of the related issues (Brown, 2008, and others, cited in Wong & Brown, 2009).

At the other end of the spectrum, in order to move to more sustainable and resilient urban systems, or to a ''Water Sensitive City'' that integrates water services provision security, health security, flood control, waterway and environmental protection, recreation, economic growth and generational fairness, an holistic revamping of the hydro-social frame and *socio-political drivers* are required, opposing to the previous narrow focus on specific parts of the water cycle. (Wong & Brown, 2009; Barron, et al., 2016). For some researchers, for example (Lundqvist et al 2001, cited in Wong & Brown, 2009), this frame can be described as the *''hydro-social contract''*, expressing this way the agreements (implicit or not), institutions and beliefs among governments, communities and businesses, regarding water management, on the basis of cultural, political, historical and other traits.

Having regard to the clear demand for a shift in more holistic, flexible and adaptive approach in order to respond to fragmentation in decision-making and, at the same time combat the current multiple stressors that jeopardize human health, well-being and prosperity in many ways across the globe, in this chapter, the most prevailing concepts for sustainable urban water management will be discussed.

National and international governmental and non-governmental organizations, regulatory bodies, scholars and researchers have tried to develop and implement good practices, so as to promote change that guarantee the necessary balance between resources use and preservation.

Many concepts have been developed in this direction, among the most known and prominent of which are the ''Integrated Water Resources Management'' (IWRM), the ''Sustainable Urban Water Management'' (SUWM), the ''Water Sensitive Urban Design'' (WSUD) (Wong, 2006, cited in Wong & Brown, 2009), which comes from the integration of the ''Integrated Urban Water Cycle Planning and Management'' (IUWCM) and the ''urban design'' (Wong & Brown, 2009), to conclude on the ''Water Sensitive City''. The bounds among them are blurred, having many elements in common.

4.1. The *Integrated Water Resources Management* concept

The ''Integrated Water Resources Management'' has been developed and it is now applied as a modem water management approach internationally (Hooper, 2003; Gain, Rouillard, & Benson, 2013). It can be considered as an *umbrella concept* (Gain, Rouillard, & Benson, 2013)*,* which, despite the variations in its conceptualization, according to the context (Gain, Rouillard, & Benson, 2013), aim to include a plethora of environmental, physical, social and economic parameters and its interconnections in the water management, so as to meet sustainable and cost-effective societal and environmental objectives (Hooper, 2003; Agarwal, et al., 2000). In addition, IWRM, with this inclusion, promotes a more coordinated and cohesive management of various aspects of water resources systems, both spatially and temporally, basically in a river basin scale, taking cognizance of the complicated interaction among water and other sectors, for example land development. (Hooper, 2003; Gain, Rouillard, & Benson, 2013)

For many researchers, IWRM is considered as an optimal action plan to manage water resources, since it has a holistic and inclusive strategic view and also embraces the good governance principles (Gain & Schwab cited in Gain, Rouillard, & Benson, 2013). As it is anticipated, critiques and difficulties in application are not missing, as it will be discussed later.

4.1.1. Synoptic history of the IWRM concept evolution

Although IWRM concept origination is arguable vague, as many researchers define its beginning in the early 20th century, while others only in 1990s (Bakker K, 2013), an important start towards the integration water resources management in basin level have been done in 1930s, when the Tenesse Valley Authority (TUA) was founded. TUA is a federal corporation in the USA which has launched a holistic

resources management to trigger development with large-scale engineering plans that also became exemplar for other countries in S. America, Asia, Africa in 1940s. Decades of 1970s-1980s are characterized by more centralized spirit and weakened interesting in river basin level approach in water management. The relative lack of success of this orientation led again to more integrated ways. The first international effort for coordination with IWRM ideas has been made in UN's Mar the Plata Conference on Water (1977), central aim of which was the collaboration among different water-related sectors. As universal principles, IWRM concept has been codified at the International Conference on Water and the Environment (ICWE), (Dublin, 1992), for the preparation of United Nations Conference on Environment and Development (UNCED), also known as Rio de Janeiro Earth Summit (1992). These principles highlight the finite and economic nature of water and the stakeholders' participation as well. In 1998, the European Commission (EC) released a set of guidelines named ''Towards Sustainable Water Recourses Management: A strategic Approach'', as a tool for international cooperation and consensus on IWRM. Recent noteworthy milestones in IWRM evolution were the Millennium Development Goals (2000), the European Union's Water Framework Directive (2000) and the Johannesburg Summit on Sustainable Development (2002). Since then, IWRM has been expanded and adopted to a different extent in many parts of the world. (Benson D., Gain, A., & Rouillard, J, 2015; Butterworth, Moriarty, & Smits, 2010; Stålnacke, 2010; Bakker & Morinville, 2013).

4.1.2. Defining IWRM

Similarly to the water governance definition, there is vagueness on IWRM definition and also there is no universally accepted blueprint on how IWRM principles can be put into practice, since local conditions demand diversity and lack of uniformity. (Agarwal, et al., 2000; Gain, Rouillard, & Benson, 2013)

In order to create common understanding on IWRM concept Global Water Partnership (GWP, 2000) has tried to clarify IWRM scope and process. As a result, according to the definition of GWP, ''*IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.*'' (Agarwal, et al., 2000).

In the above definition is recognized the integral value of water for the economic and social well-being, and the need for equity, efficiency and sustainability in resources keeping pace with the statement of the United Nations Development Programme (UNDP) that ''*Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and social and economic good*'' (United Nations Development Programme 1990: 22, cited in Cardwell Hal, Cole, Cartwright, & Martin, 2006). In addition, it makes evident that

IWRM is a process to reach a goal and it is not the goal itself, perception which is also shared with other researchers as well, for example Cardwell Hal, Cole, Cartwright, & Martin, 2006

For Ballweber, 2006, cited in Gain, Rouillard, & Benson, 2013, *"IWRM is blending or integrating actions and objectives favored by different players to achieve the best total result within a river basin or watershed".*

This point of view underlines the need for wide participation of the affected parts in water management related issues, in river basin or watershed level.

Savenije and Van der Zaag, 2008, cited in Gain, Rouillard, & Benson, 2013 define of IWRM in terms of four dimensions: water resources; water users; spatial scales; and temporal scales.

According to Cardwell Hal, Cole, Cartwright, & Martin, 2006, *''Integrated Water Resources Management is coordinated, goal-directed process for controlling the development and use of river, lake, ocean, wetland, and other water assets.''*

In this definition is stressed out the goal-directed, yet not single-oriented nature of the IWRM concept. The desired objectives of an IWRM project can be various and, sometimes hierarchically posed. (Cardwell Hal, Cole, Cartwright, & Martin, 2006). However, Cardwell Hal, Cole, Cartwright, & Martin, 2006, also notice that this is a difference between this definition and the definition of the GWP, which consider as specific goal the maximization of social and economic welfare, with fair and sustainable way. Nevertheless, it can be argued that in this general framework that is posed by the GWP, many other objectives can be laid, so there is no profound contradiction between the two definitions.

For the U.S. Agency for International Development (USAID*), ''IWRM brings together governments, communities, and other stakeholders to choose among alternative uses of freshwater and coastal resources. Using a participatory planning and implementation process, these stakeholders identify ways to meet their diverse water needs without depleting or damaging water resources and their underlying ecosystems''* (U.S. Agency for International Development 2003: 1, cited in Cardwell Hal, Cole, Cartwright, & Martin, 2006).

The World Bank describes that *''an integrated water resources perspective ensures that social, economic, environmental and technical dimensions are taken into account in the management and development of water resources'',* without defining the term IWRM. (World Bank 2003a:1, cited in Cardwell Hal, Cole, Cartwright, & Martin, 2006).

Another, more complicated definition comes from the Inter-American Development Bank (IADB), which defines the IWRM as *'' water resources management where the*

aim of its actions and projects also includes the allocation of water and decreasing of conflicts between competitive water resource subsectors and uses, both in quantity and in quality. Sometimes it is also referred to as comprehensive water resources management…It is the process of diagnosing, responding to and resolving water use problems [while] acknowledging their interrelationships'' (Inter-American Development Bank 1998: 3 cited in Cardwell Hal, Cole, Cartwright, & Martin, 2006).

For Gain, Rouillard, & Benson, 2013, *''IWRM—in its contemporary form—is an integrated form of sustainably managing water and associated resources at the river basin scale involving specific governance forms that guarantee multi-stakeholder participation, equitable access and efficient use of water resources''.*

The important addition in this definition is the changing nature of IWRM. Changing circumstances demand updating of the concept, in order for it to be adaptive, effective and context-related.

Generally speaking, as it can be inferred from the above definitions, despite slight differences, it is commonly accepted that the IWRM concept encourages the multi-viewed and multi-voiced approach on water management, working in a sustainability and fairness framework. Moreover, in almost all definitions are placed in front the rationales of water efficiency, social equity and environmental sustainability (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010). Nevertheless, as Molle, 2008, cited in Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010, underline, it is almost impossible all these objectives to be maximized at the same time, as it, sometimes, implicitly suggested. The best case scenario in this situation is, according to Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010, to achieve equilibrium.

4.1.3. IWRM principles-application challenges

When it comes to the IWRM principles, it must be noticed that there is a number of general guidelines for the application of IWRM in specific contexts, yet a blueprint, as Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010 recognize, cannot be developed. The Dublin Rio Principles can be considered as the main principles guiding the IWRM concept. (Agarwal, et al., 2000). Good governance principles can also be very assisting as well.

Significant components for the facilitation of IWRM development and application can be considered (Agarwal, et al., 2000; Lenton and Muller, 2009, cited in Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010):

- *the enabling environment*, including national legislation, policies, goal setting, financial, investment and information mechanisms
- *the institutional roles* of governance levels and stakeholders participation

- *the management and instruments*, including effective regulation, controlling and implementation mechanisms

Besides the above general directions, it is also evident and widely agreed that, due to the fact that different hydrological, social, political, economic and other circumstances generate different interpretations, needs and actions, the conceptual understanding, framing and application of IWRM diversifies in every case, creating different forms of IWRM. (Hooper, 2003; Green and Fernández cited in Hooper B., 2006; Stålnacke & Gooch, 2010) As a consequence, attention must be given on the evaluation of IWRM programs, which must be context-based, as well as on the review of the relative literature, for the same reason (Hooper B., 2006; Stålnacke & Gooch, 2010).

In addition to this vagueness, various challenges have been emerged or detected after research, in the implementation of IWRM, related to social, administrative institutional and operational barriers, for example poverty, lack of knowledge in environmental, institutional and decision making issues, deficient co-ordination, ineffective local institutions, lack of economic and environmental integration, inadequate natural resources management framework, users conflicts, lacking financial assessment and support, lack of social impact monitoring and others. (Hooper, 2003)

4.1.4. The ''integration'' issue

In the analysis of the Integrated Water Resources Management, one critical question in literature is the kind of integration that is required in the management of water resources (Cardwell Hal, Cole, Cartwright, & Martin, 2006), as well as the extent of this integration. Various degrees of communication and cooperation may exist in activities at local, regional and national level (Cardwell Hal, Cole, Cartwright, & Martin, 2006), or even at international level. It is also essential to add that integration practices can be taken from a household to international markets level (Agarwal, et al., 2000). For Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010, the purpose of the integrated management is to alleviate the adverse consequences of a sub-actor's actions on the other related actors, controlling disagreements and inefficacy.

The understanding of the term ''integration'' in water resources management varies among researchers. For instance, for Cardwell Hal, Cole, Cartwright, & Martin, 2006 there are (at least) four types of integration:

- *Spatial Integration*: coordinated objectives and activities within a specific geographic area and the layers among lithosphere and atmosphere. Finding the right spatial unit for the analysis, which covers every important effect and at the same time, effective decision-making is possible is a challenge for

IWRM. It is also important to mention that the action planning in water management often becomes in an area defined by hydrological terms, while the economic and environmental evaluation is based on an area defined by *business-system* interaction, and the two areas may be not the exactly the same.

- *Objective Integration:* coordinated objectives for many aspects of water management, such as water supply, agriculture, floods, hydropower, navigation, recreation and others. The importance of each objective can be valorized by its effects on water condition. In addition, it is useful to remember that may be exist divergent objectives between local and national level.

- *Institutional Integration:* coordinated action proposed or imposed by various governmental and non-governmental bodies through measures, policies and projects

- *Temporal integration*: coordinated action in terms of different times scales, for example from daily to decades basis provision for different operations. For example, in water supply provision, there is a part of the plan with long-term vision of the demography, economy and land use, while there is need for other part of the plan to operate on, for instance, a daily or hourly basis. Except for this leg, temporal integration is also important, considering the changing environmental, social and economic conditions, enabling adaptive capacity of IWRM.

Another perspective of integration is given by Agarwal, et al., 2000, according to which integration is about the mix of the right proportion of the ingredients and it is necessary, but not sufficient condition for optimal management practices. For Agarwal, et al., 2000, there are two categories, within and among them integration can take place: the natural systems, important for water quality and quantity, and human system, responsible for water usage. The main components of each category are presented as follows (Agarwal, et al., 2000):

- *Natural system integration*:
  - *Integration of freshwater management and coastal zone management,* especially considering the *upstream-downstream issue*
  - *Integration of land and water management,* since land use affect physical water allocation and quality, along with the importance of water for the maintenance of terrestrial and aquatic ecosystems
  - *Integration of ''green water''* (water used for biomass production and consumed in evapotranspiration) *and ''blue water''* (surface and groundwater freshwater). While the emphasis is given on ''blue water'', ''green water'' management is considerable factor in water saving and ecosystems protection

- *Integration of surface water and groundwater management,* given the irreparable of groundwater pollution, in terms of human timescale, existing technology and cost required
- *Integration of quantity and quality in water resources management*
- *Integration of upstream and downstream water-related interests,* since upstream consumption, pollution, flood control and land use can cause downstream vulnerability or degradation, as well as conflicts among users
- *Human system integration:*
  - *Cross-sectoral integration in national policy development,* since economic and social policies, for example food or energy policies may deeply affect water resources and vice versa
  - *Macro-economic effects of water developments*
  - *Integration of all stakeholders in the planning and decision process,* identifying them at each level of water policy implementation
  - *Integration of water and wastewater management,* since, where is suitable, wastewater can be effectively reused for specific purposes, keeping in mind that wastewater can also be pollutant, without proper provision for the opposite

4.1.5. Criticism of the IWRM concept and implementation

Despite the fact that IWRM is a popular and widespread concept, supported by prominent organizations and governments, it is also controversial, since it is concept and implementation are criticized by a part of researchers.

One common criticism comes from the conceptual ambiguity, as it has been discussed before. For some, for example Biswas, 2008, cited in Gain, Rouillard, & Benson, 2013, this imprecision is considered as a substantive factor for the success of the IWRM diffusion, since it offers an array of similar interpretations and practices, while others support that this may generate confusion and increased gap between policy making (taking place at a large scale) and implementation (taking place at a local level) (Gain, Rouillard, & Benson, 2013), or even it may be used as a *''mask''* for *''other agendas''* (Giordano & Shah, 2014).

Another critique says that the Integrated Water Resources Management now becomes IWRM with capitals, *a necessary condition*, an end itself rather than a means to achieve improved management of resources, in many cases having donors' endorsement. (Giordano & Shah, 2014) In this way, alternative thinking on water related problems solving might be inhibited (Giordano & Shah, 2014), or, due to the fact that it seems that IWRM-based projects are promoted and sponsored, many continue their previous practices that renamed them within the IWRM frame (Biswas, 2004, cited in Giordano & Shah, 2014).

Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010 claim that IWRM is mostly suitable for developed countries, since its reformation and enforcement have been proved to be time- and money- consuming and not so effective, so far. In addition, in some developing countries, IWRM seems to be unrelated to the existing reality and externally enforced, so it is a risk to not be embraced by local people. Given that, even in the development counties, there are effective arrangements, even though not being sustainable or just (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010), attention should be given on maintaining the good practices and changing the insufficient ones. So, as Giordano & Shah, 2014 assert, in some cases IWRM is not appropriate or desirable and also it is more realistic to start from what is already in place and not from the scratch (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010).

One more debatable issue is that of the appropriate planning unit in water management. IWRM proposes river basin as the most befitting management unit, for many reasons (Jaspers, 2003, cited in Gain, Rouillard, & Benson, 2013; Giordano & Shah, 2014; Cardwell Hal, Cole, Cartwright, & Martin, 2006). For instance, it said to be that the management within a hydrological unit with physical borders as the river basin becomes more coherent and efficient (Gain, Rouillard, & Benson, 2013), because it can integrate land and water use, it can manage upstream-downstream as well as quantity and quality issues (Cardwell Hal, Cole, Cartwright, & Martin, 2006), and also it is believed that promotes a greater collaboration among nations, providing higher possibility for water security (Zeitoun and others, 2013, cited in Bakker & Morinville, 2013). On the other hand, river basin approach is not always administratively or ecologically feasibly (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010), given that river basins often extend over different administrative, social and political boundaries, making IWRM application difficult (Gain, Rouillard, & Benson, 2013). For this reason, Lenton and Muller, 2009, cited in Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010 claim that IWRM is possible to be applied in every level, from local, to basin, national or transboundary, according to the special needs and condition of each instance.

Another assertion accuses IWRM to exhibit both a token participation of stakeholders, limited to information and consultation mechanisms play (Cleaver, 1999; Currie-Alder, 2007, cited in Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010) and an not *''people-centered' '*interest, especially for the marginalized groups (Merrey et al., 2005, cited in Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010). So, in order to create meaningful stakeholders participation, better mechanisms are required (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010).

The viewpoint of IWRM regarding the politics has also been on the spotlight, since many argue that IWRM pays little attention or tries to depoliticize procedures and

activities, when politics is considered to be essential pillar for public engagement and paradigm shift (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010).

Taking everything that have been mentioned above into consideration, it is deduced that there is no best water management scheme, but many possible alternatives, as (Ostrom, Stern & Dietz, 2003 cited in Giordano & Shah, 2014) have said.

4.1.6. Alternative approaches

4.1.6.1. The 'Light' IWRM

Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010 support that, in order to transform IWRM perspective into more realistic, context-based and service-oriented strategies a slightly different version of IWRM should be adopted, named 'light' IWRM (Moriarty et al., 2000, cited in Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010). These light forms of IWRM focus to a greater extend on local and sub-sectoral levels, actors engaged and relevant proceedings of policy-making, implementation, monitoring and assessment, considering that if good practices are applied on lower levels or sectors can more easily been transferred in upper levels of governance (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010). In this way, every sector is activated and sectoral participation and coordination are probably enhanced, facilitating the integration process (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010). On the other hand, focusing on the lower levels the greater picture of large scale issues may be ignored or could not be resolved, and, additionally, it demands more active public engagement, which is not always easy to be achieved. (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010) Yet, these lighter IWRM approaches can be potentially applied and on higher levels, for example at river basin or national level, as (Butterworth John, Warner, Moriarty, Smits, & Batchelor, 2010) suggest.

4.1.6.2. The 'Nexus' approach

Another alternative governance concept, which also promotes water resources security through energy, agriculture and climate concerns integration, is the *nexus approach*, aiming at assisting societies' transition towards greener and more sustainable development. The emergence, novelties and commonplaces between nexus and IWRM approaches are vague enough and the main goal of both is the sustainable usage of resources, therefore the differences should be detected. As indicator axes, in this comparative analysis, have been used the following:

- *Policy integration:* IWRM perspective can be considered as *''water centric''*, in other words it seeks to integrate water with other sectors, while the nexus

approach can be considered as *"multi- centric"*, because every sector is construed as equal to the others, and the integration is for all of them

- *Optimal governance:* While IWRM follows good governance principles, the nexus approach does not offer many normative governance principles
- *Optimal scale:* While IWRM basically supports the river basin scale, the nexus approach promotes multiple scales
- *Stakeholder participation:* IWRM encourages multiple stakeholder participation and the nexus focuses on public-private partnerships
- *Resource use:* IWRM fosters fair access, efficient distribution and cost recovery, while the nexus approach proposes economic feasibility in decision making and cost recovery
- *Sustainable development:* IWRM promotes the demand management, while the nexus approach supports resources securitization

(Benson, Gain, & Rouillard, 2015)

4.1.7. The *City Blueprint Methodology*

The ''City Blueprint Methodology'' have been developed in 2011, to evaluate the sustainability of IWRM in regions and municipalities (Van Leeuwen et al. 2012, cited in Koop & Van Leeuwen, 2016), taking into account the most strategic IWRM actors (Philip et al. , 2011, cited in Koop & Van Leeuwen, 2016), while the City Blueprint indictors are founded on the *3Ps in the water cycle* (People, Planet and Profit) (Van Leeuwen et al. 2012, and others, cited in Koop & Van Leeuwen, 2016).

The City Blueprint Methodology contributes a practical framework to regions and municipalities, assisting them in their transition to more resilient and sustainable water management, with the cooperation of key actors related. The focus of this methodology is basically on European cities, yet an effort has been made to include other areas in the world as well. (Koop & Van Leeuwen, 2016)

The cities included in the research connected to the development of the City Blueprint Methodology have been categorized according to their *Blue City Index (BCI)*, which is the geometric mean of 25 environmental, financial and social indicators, as well as their *Trends and Pressure Index (TPI),* which is the arithmetic average of 12 indicators, providing an insight of the current performance of IWRM. (Koop & Van Leeuwen, 2016)

The description of each city's IWRM categorization, according to (Koop and Van Leeuwen 2015b, cited in Koop & Van Leeuwen, 2016) is presented below:

- ***Cities lacking basic water services (BCI 0–2)****: Access to potable drinking water of sufficient quality and access to sanitation facilities are insufficient. Typically, water pollution is high due to a lack of wastewater treatment*

(WWT). Solid waste production is relatively low but is only partially collected and, if collected, almost exclusively put in landfills. Water consumption is low, but water system leakages are high due to serious infrastructure investment deficits. Basic water services cannot be expanded or improved due to rapid urbanization. Improvements are hindered due to governance capacity and funding gaps.

- **Wasteful cities (BCI 2–4)**: Basic water services are largely met but flood risk can be high and WWT is poorly covered. Often, only primary and a small portion of secondary WWT is applied, leading to large-scale pollution. Water consumption and infrastructure leakages are high due to the lack of environmental awareness and infrastructure maintenance. Solid waste production is high, and waste is almost completely dumped in landfills. Governance is reactive, and community involvement is low.

- **Water-efficient cities (BCI 4–6)**: Cities implementing centralized, well-known, technological solutions to increase water efficiency and to control pollution. Secondary WWT coverage is high, and the share of tertiary WWT is rising. Water-efficient technologies are partially applied; infrastructure leakages are substantially reduced, but water consumption is still high. Energy recovery from WWT is relatively high, while nutrient recovery is limited. Both solid waste recycling and energy recovery are partially applied. These cities are often vulnerable to climate change, e.g. urban heat islands and drainage flooding, due to poor adaptation strategies, limited storm water separation and low green surface ratios. Governance and community involvement has improved.

- **Resource-efficient and adaptive cities (BCI 6–8)**: WWT techniques to recover energy and nutrients are often applied. Solid waste recycling and energy recovery are largely covered, whereas solid waste production has not yet been reduced. Water-efficient techniques are widely applied, and water consumption has been reduced. Climate adaptation in urban planning is applied, e.g. incorporation of green infrastructures and storm water separation. Integrative, centralized and decentralized as well as long-term planning, community involvement and sustainability initiatives are established to cope with limited resources and climate change.

- **Water-wise cities (BCI 8–10)**: There is no BCI score that is within this category so far. These cities apply full resource and energy recovery in their WWT and solid waste treatment, fully integrate water into urban planning, have multi-functional and adaptive infrastructures, and local communities promote sustainable integrated decision-making and behavior. Cities are largely water self-sufficient, attractive, innovative and circular by applying multiple (de)centralized solutions.
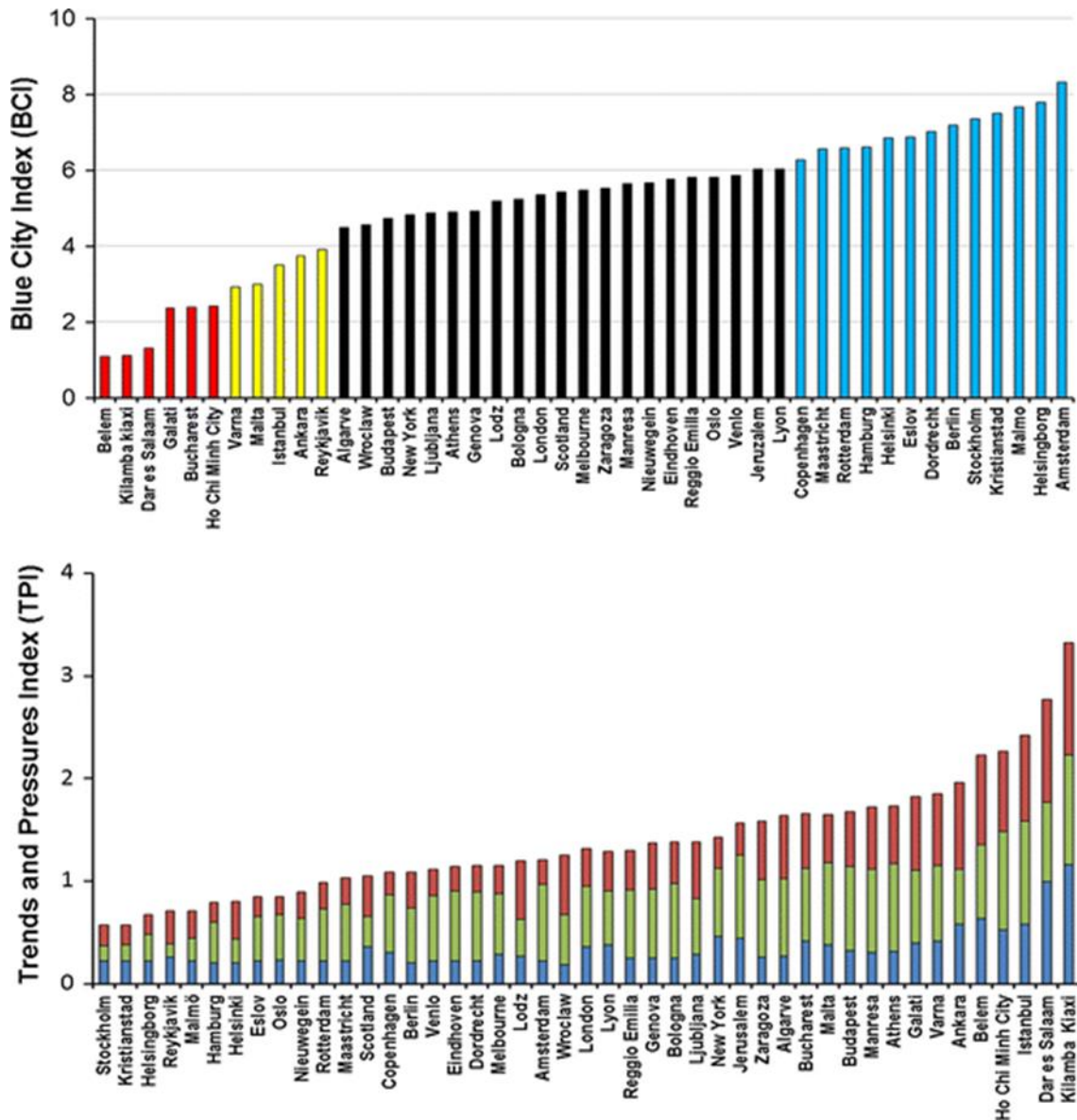
Figure 12: City Blueprint Analysis of 45 municipalities and regions in 27 countries results (Source: (Koop & Van Leeuwen, 2016)

In Figure 12, the red, green and blue colors represent the share of the financial, environmental and social indicators respectively, to the overall TPI. (Koop & Van Leeuwen, 2016)

Figure 13: Municipalities and regions evaluated with the City Blueprint

4.2. The *Sustainable Urban Water Management* concept

The ''Sustainable Urban Water Management'' (SUWM) concept embraces both ''Integrated Urban Water Management'' (IUWM) concept and ''Water Sensitive Urban Design'' (WSUD) (Mitchell 2006; Fletcher et al., 2015, cited in Barron, et al., 2016) and it was proposed as a response to various urban pressures, related to water and environment in general, providing resilience and security. (Brown, Keath, & Wong, 2009) Technological innovations and increased public awareness in some cases have brought about a shift towards SUWM, but many argue that this progress is slow (Brown et al, 2007, cited in Brown, Keath, & Wong, 2009), due to the lack of a benchmarking procedure that informs for the development of the concept in every case (Gleik,2003, cited in Brown, Keath, & Wong, 2009), so it is difficult for the professionals or scientists to have a feedback for the long-term practices and results. Furthermore, Barron, et al., 2016, despite the fact that recognize that the proper respond to the pressures are the application of Sustainable Urban Water Management principles, also point out that a range of possible economic, institutional, social and technological hindrances must be firstly overcome. Among these obstacles are (Roy et al.,2008 ; Goff & Crow, 2014, cited in Barron, et al., 2016): poverty and marginalization, limited institutional and legislative capacity, lacking technical guidelines and standards, insufficient funding incentives, undetermined alternative solutions performance and cost demanded, as well as resistance to change. It can be easily noticed that these barriers affect a plethora of situations and concerning domains.

4.3. The *Water Sensitive Urban Design* concept

The Water Sensitive Urban Design (WSUD) has gain a lot of attention in the recent years, as means to deal with current and future challenges of urbanization, climate change and inadequate water related infrastructure. Urban storm water and flood management, water and landscape conservation, and social well-being are among the topics that WSUD tries to deal with sustainably. (Lerer, Karsten, & Mikkelsen, 2015; Sharma, et al., 2016)

The concept of WSUD aims to ensure water systems' sensitivity and integration in urban areas, placing water functions as well as water protection and provision in prominent position in urban operational and development planning, with the contribution of interdisciplinary cooperation, as a means to guarantee public and environmental protection and *economic sustainability.* (Wong & Brown, 2009; Ashley, et al., 2013). For some researchers, for instance Sharma, et al., 2016, WSUD is considered as IWRM's component. WSUD can be implemented in various spatial and temporal scales, offering increased adaptability. (Ashley, et al., 2013)

4.3.1. Defining WSUD

As in the majority of the efforts to define a concept, there is once again plurality in the WSUD definitions. In fact, as Ashley, et al., 2013 support WSUD is a *process* more than *an end condition.*

According to Joint Steering Committee for Water Sensitive Cities, 2009, cited in Leonard, et al., 2014, WSUD can described as *''the integrated design of the urban water cycle where water supply, wastewater, storm water, groundwater, urban design and environmental protection are all incorporated''.*

For National Water Initiative, 2004, cited in Leonard, et al., 2014 and Sharma, et al., 2016, WSUD is defined as *"The integration of urban planning with the management, protection and conservation of the urban water cycle that ensures urban water management is sensitive to natural hydrological and ecological processes."*

The Government of South Australia, 2013, cited in Leonard, et al., 2014 delineates WSUD as *''an approach to urban planning and design that integrates the management of the total water cycle into the land use and development process.''*

As it can be noticed the above definitions are similar enough and they express the need for the integration of water cycle in the urban functioning and planning, as WSUD is considered to be facilitator in this integration process (Wong, 2006b, cited in Ashley, et al., 2013, through identifying alternative management solutions based on their environmental, economic and social feasibility, fruitfulness and minimal footprint (Ashley, et al., 2013).

According to the WSUD perspective, every part of the urban water cycle can be deemed as a valuable resource, taking into account the special site features (Sharma, et al., 2016).

4.3.2. WSUD principles, objectives and challenges

According to Ashley, et al., 2013, the main principles that suitably underpinning WSUB's adoption in United Kingdom and in European Union in general are:

- Integrated and concurrent water quality and quantity management
- Water cycle management and use at the most local level possible, considering every side of water as potentially useful
- Proper and synergistic water management in combination with urban services planning and ecosystem protection

The above overall guidelines may be put into practice following more specific objectives, according to each case reality. There are general goals that WSUD advocates, among which are these listed below (Department of Planning and Local Government, 2010b; Joint Steering Committee for Water Sensitive Cities, 2009 cited in Leonard, et al., 2014; Leonard, et al., 2014; Ashley, et al., 2013:

- Decrease in the demanded amount of drinkable water
- Decrease in the produced amount and impact of wastewater
- Preservation and repair of natural catchments
- Decrease in flood risk
- Amelioration of aesthetic quality of local environment and of water and community connections
- Promotion of water-connected self-efficiency
- Decrease in provision and maintenance costs for related infrastructure
- Decrease in greenhouse gas emissions
- Providence for runoff's storage, treatment and appropriate use
- Providence for wastewater treatment and reuse
- Enhancement of biodiversity and better microclimate through vegetation and *integrated vegetated surface water treatment and harvesting systems* in the landscape

Many strategies and mechanisms may facilitate the achievement of the above targets, or the targets and the site-specific conditions of each case (Leonard, et al., 2014). The essential note here is that every form of water proffers opportunities for the community to address current and future water connected tensions (Ashley, et al., 2013). In light of this the development of a water recourses portfolio may enhance city's autarky and adaptability (Leonard, et al., 2014). Decentralized systems, with their possible integration with centralized systems, which have incorporated WSUD orientation have been proposed as a response in the actual

urban needs (Cook et al., 2009, cited in Leonard, et al., 2014). Sharma et al., 2013, cited in Leonard, et al., 2014 define decentralized systems as *''systems provided for water, wastewater and storm water services at the allotment, cluster and development scale that utilise alternative water resources including rainwater, wastewater and storm water; based on a 'fit for purpose' concept.''* One of the main aims of decentralized systems is to treat water near the source of generation. (Leonard, et al., 2014) Institutional arrangements, with flexible and long-term vision, monitoring mechanisms and usage of water efficient devices and systems might also provide useful help in the WSUD application. In addition, cost-benefit analysis of the environmental services is also required, even though the necessary relevant methods are under development, due to the complicated nature of environmental management (Defra, 2007, cited in Ashley, et al., 2013).

Rain gardens, green roofs, infiltration systems, rainwater tanks, pervious pavements, sedimentation basins, constructed wetlands, siphonic roofwater systems, have been used, inter alia, as a part of a WSUD planning in South Australia. (Sharma, et al., 2016)

Considering the fact that the WSUD systems are mostly innovative, institutional, technical, economic and social elements adversely affect their implementation, due the lack of relative knowledge. (Sharma, et al., 2016) Some of the commonly detected barriers in the WSUD plans application are the following (Leonard, et al., 2014; Sharma, et al., 2016):

- Incomplete public information and awareness on the problems at hand and the potential benefits of WSUD
- Malfunctioning of WSUD systems, especially at their initial stages that makes decision-makers, investors and public hesitant towards them
- Problems in long term engagement and maintenance of management system in human resources, financial and technical terms
- Insufficient bidirectional dialogue and feedback between WSUD facilities' operators and local community
- Cost uncertainties due to unexpected expenditures and doubtful financing
- Lacking monitoring mechanisms in order to control WSUD systems effectiveness
- Conflicting objectives of the WSUD systems, due to their *multi-functionality*

In light of these, mechanisms that firstly encourage the usage of alternative water sources and WSUD ideas in general, secondly ensure proper function of the WSUD systems and thirdly facilitate the continuous training, information and knowledge of all actors related are among the necessary prerequisites for successful WSUD implementation (Leonard, et al., 2014).

4.4. Moving toward Water Sensitive Cities

4.4.1. *Water Sensitive City* concept

As the static water resources management is no longer sufficient, due to the more unpredictable circumstances, the Water Sensitive City approach proposes a water management concept capable of meeting the city's current needs for water in an optimal manner, while ensuring city's liveability and resilience (Brown, Rogers, & Werbeloff, 2016). Resilience, according to Wong & Brown, 2009, reflects the quantity of disturbance that a system can accept, maintaining constant conditions and developing self-organization, learning and adaptive capacities.

Water Sensitive City is a conception founded on holistic water cycle management, with primary objectives the protection of waterways, ecosystems and biodiversity, the flood and climate change's impacts control in general, and the creation of public areas for harvesting, cleaning up and recycling water, as well as green spaces free to all. (Brown, Rogers, & Werbeloff, 2016) This concept also supports water use in a fit for purpose manner, with the contribution of centralized and decentralized infrastructure, integrating water in urban design and creating, eventually, living communities (Brown, Rogers, & Werbeloff, 2016).

In addition to the above, an important element in Water Sensitive City is its ''context-based'' orientation, meaning that, besides general guidelines, the development and application of water sensitivity principles in every city across the globe depends on a variety of factors, inter alia environmental, climatic, geographical, historical, demographical, governmental and institutional parameters which affect the understanding and capacity in the adoption of practices that bring water sensitivity in urban areas (Brown, Rogers, & Werbeloff, 2016).

4.4.2. The *Urban Water Transitions Framework*

In order to move to more environmentally friendly ways of production and consumption, multi-dimensional transitions of systems' values, architecture and practice are needed (Brown, Rogers, & Werbeloff, 2016). This transformation usually takes around 25-50 years to be concluded, due to its complex nature (Brown, Rogers, & Werbeloff, 2016). Despite the differences between the developed and developing countries, the initial point of very attempt for a change is the knowledge of the actual water management practices status, along with the short and long term objectives for sustainable development (Brown, Rogers, & Werbeloff, 2016).

Brown et al., 2009, cited in Brown, Rogers, & Werbeloff, 2016 have developed an ''Urban Water Management Transitions Framework'' for the transition towards a water sensitive city, to facilitate this procedure. This transitions framework, based on

research on Australian cities, yet potentially applied in european or developed countries' conditions in general, can be used as a supporting tool for the progression of policy structures in order to move to an urban sustainable reality, identifying the limitations and the necessary changes, as well as being a benchmarking and conceptual implement, tailored to each specific context. It offers a typology of city features of previous, current and future hydro-social contracts, in their evolution to water sensitive city. (Brown, Keath, & Wong, 2009; Brown, Rogers, & Werbeloff, 2016). It is composed by six sequential stages of the city in this shift and, as a result, the hydro-social contract of each state has an effect on the next's state. (Wong & Brown, 2009) Of course, every city is in a different stage in this linear classification, and there is a possibility of moving in both directions or of even leaping stages (Keath & Brown, 2008, cited in Brown, Keath, & Wong, 2009). Nevertheless, this framework still remains hypothetical, according to Brown, Keath, & Wong, 2009, due to lack of verification of other countries. In addition to the lack of verification, lack of need can also be added. In this respect, for example, Binz et al., 2012, cited in Barron, et al., 2016 maintain the ''leap frogging theory'', according to which developing countries may be preferable to leapfrog stages and technologies already used and been proved insufficient by developed countries and to adapt more innovative, ecological and sustainable schemes in production and consumption at once (Barron, et al., 2016).
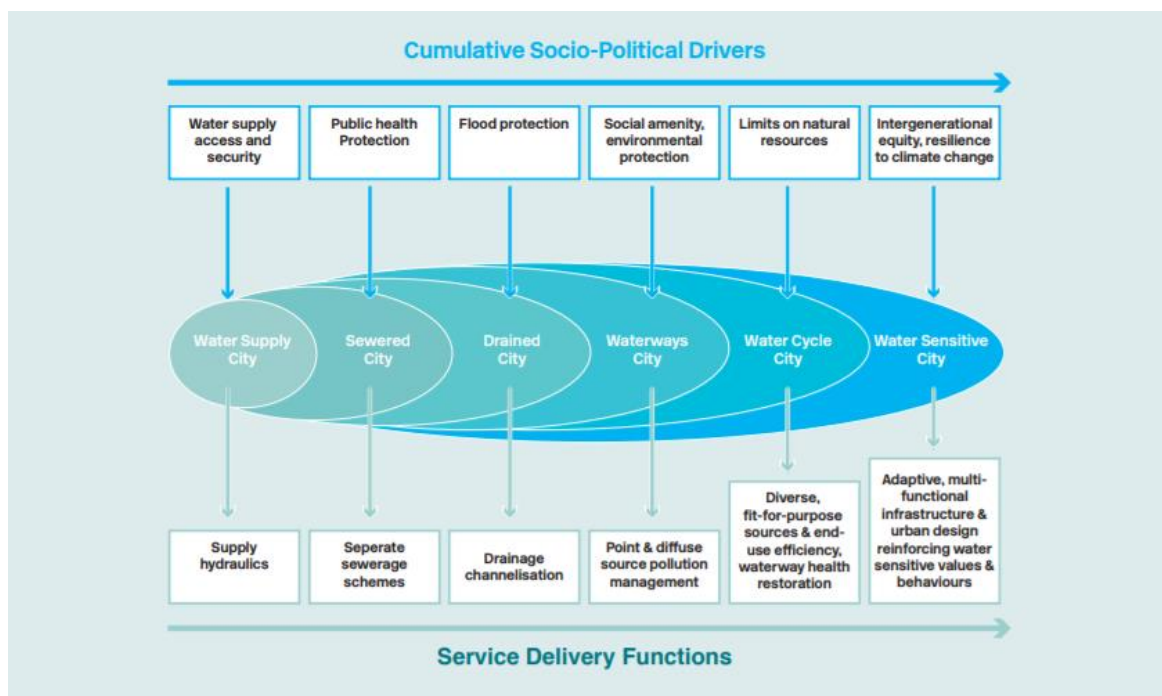

Figure 14: Urban Water Transition Framework (Source: Brown et al., 2009, cited in (Brown, Rogers, & Werbeloff, 2016))

According to Brown et al., 2009, cited in Brown, Rogers, & Werbeloff, 2016, the main frame of each water management city- state are as follows:

- **Water Supply City**: *The most basic state of modern water management, whereby a centralized system provides water to a growing urban population that expects cheap and equitable water for all. Large quantities of water are extracted from the environment using infrastructure such as pipes and dams. The public expects that water is cheap, harmless to the environment and limitlessly available.*

- **Sewered City**: *Building on the previous state, the Sewered City is drive by a desire for better public health and hygiene. Diseases caused by domestic and industrial waste effluent leads to the development of sewerage systems that divert effluent away from housing and into waterways outside of cities. As in the earlier state, it is assumed that the discarding of effluent does not harm the environment.*

- **Drained City**: *A need to protect homes and infrastructure from flooding is the driver behind the Drained City. The channelling of rivers enables the development of floodplains for housing and rapid urban growth. Like effluent, stormwater is directed away from urban areas and into waterways, generally thought of as dumping grounds for waste. The community expects water supply, sewerage and drainage services to be provided cheaply.*

- **Waterways City**: *The environmental impacts of both water extraction and waste processing are taken into account for the first time. As the social and aesthetic values of clean waterways are extolled, urban planning begins to integrate water as an important consideration. The unfettered extraction of freshwater is now being curbed, and receiving waterways are protected by filtering stormwater through bio-filtration systems such as rain gardens and artificial wetlands distributed throughout the city.*

- **Water Cycle City**: *In this state, water is actively conserved and supplies from diverse sources such as stormwater, greywater and recycled wastewater are used in a fit-for-purpose manner. Sustainability is now widely embraced, and the former hydro-social contract, in which government was expected to deliver risk-free water supply services, has been replaced with co-management arrangements between government, business and community.*

- **Water Sensitive City**: *Based on holistic and integrated water cycle management that meets the city's water needs while also delivering a range of associated liveability benefits. A Water Sensitive City manages water in a way that protects the health of receiving waters, mitigates flood risk and creates green public spaces that also harvest and recycle water. Infrastructure, technology and urban design will be flexible, recognizing the link between society and technology. The community is actively engaged with water, through recreational enjoyment of irrigated green spaces throughout*

the city, and have opportunities for more active involvement in the water system.

From Brown and al, 2009, cited in Wong & Brown, 2009 analysis, it has been seen that the main structure of the hydro-social contract in the first three stages (Water Supply City, Sewered City and Drainage City), characterized by the provision for inexpensive and infinite water supply, public health and flood security, ignoring or underestimating the environmental conditions and links between the water sector and others (for example energy and carbon emission, biodiversity and others), as it has been mentioned before. As a result, environmental degradation, including water pollution and overexploitation has occurred. In the fourth stage, that of the Waterway City, the hydro-social contract branches out, including governmental institutions and non-governmental actors, such as NSO's and groups of professionals that have as basic aim the protection of the environment. In the fifth stage, the stage of Water Cycle City, becomes evident the need for sustainable and fit-for-purpose use of the resources, with co-management among government, community and business (Brown, Keath, & Wong, 2009). Finally, Water Sensitive City needs an adaptive and flexible hydro-social contract and institutional structure, accordingly, which takes into account the linkages among society, infrastructure and technology. (Wong & Brown, 2009)

The two categories that drive the change along the six stages are (Brown, Rogers, & Werbeloff, 2016):

- *Cumulative Socio-Political Drivers*, emerging from the growing public environmental awareness that causes expectations and demands
- *Service Delivery Functions,* the services needed in order to accomplish higher degree of city's sustainability

Important strategies in a water sensitive city are related to limiting the amount of both potable water imported and wastewater exported from and to other areas, with parallel efficient water resources use within the urban area. (Wong & Brown, 2009)

According to Wong & Brown, 2009 and Brown, Rogers, & Werbeloff, 2016, a water sensitive city may integrate the following three features in its structural transformation towards increased water sensitivity. These are (Wong & Brown, 2009):

- Flexible access to an array of water sources, such as *groundwater, urban storm water, rainwater (roof runoff), recycled wastewater and desalinated water*, with the relevant infrastructure, at least cost and influence on the environment. Every alternative source has different dependability, cost and environmental impact, so the dynamic optimization of the use of each source

is of utmost importance. In addition, there is a need for the provision of the corresponding infrastructure, which can be either centralized or decentralized. Particular emphasis may also been given on a ''fit-for-purpose'' water services design, as it has also been referred before.

- Urban built and natural landscapes that offer ecological functions. Green infrastructure and technology can be incorporated in urban surroundings through the cooperation of urban planners and architects.
- Institutional capacity to support and implement sustainability practices in urban water management, encouraging public awareness and acceptance, innovation, engagement and cooperation among political, governmental and non-governmental actors and industry-technology adaptation in the particular context.

According to Barron, et al., 2016, the key domains in the interdisciplinary approach, required to reach water sensitive cities are:

- *Technology and Innovation,* since there is a need for more multifunctional, flexible, low cost and environmentally friendly technological alternatives (Wong & Brown, 2009, cited in (Barron, et al., 2016)), to cover issues such as on-site management of grey or storm water, irrigation, sanitation, real-time systems response and others
- *Urban planning and design* which embrace green infrastructure and technology (for instance wetlands, ponds, rain gardens),based on local context, including geography, topography, demography, social and cultural conditions and so on, through cost-benefits and suitability analysis
- *Governance and Society:* as it has been mentioned in the previous chapter, in general, good governance principles' application facilitate the overall complicated institutional and societal shift towards a more sustainable urban water management context

Of course, interdisciplinary planning and action, although it brings multiple knowledge and differing points of view, assisting the holistic and innovative handling of a matter, it is not without its difficulties and limitations. For example, it is more time and cost consuming, as a direct result of that scientific pluralism. T-shaped professionals may facilitate the communication and cooperation among diverse disciplines and stakeholders (Brown et al. 2015, cited in Barron, et al., 2016).

4.4.3. The *Transitions Dynamics Framework*

Along with the ''Urban Water Management Transitions Framework'', another benchmarking instrument developed is the ''Transition Dynamics Framework'', which proffers an insight in the realization of the every transition stage, based on the case study of Melbourne's transition of storm water management, conducted by

(Brown, Farrelly and Loorback, 2013, cited in Brown, Rogers, & Werbeloff, 2016). As it widely accepted, the transition pathway is highly complex, demanding institutional and infrastructural readjustment of water management. (Brown, Rogers, & Werbeloff, 2016) Furthermore, more often than not, barriers such as path dependency, well established technological practices institutional fragmentation or decreased function, or even capacity matters in organizational level hold back transition's evolution (Brown, Rogers, & Werbeloff, 2016).

The Transition Dynamics Framework contains six stages through which the transition towards water sensitive cities passes, as it can be seen in the figure 15.
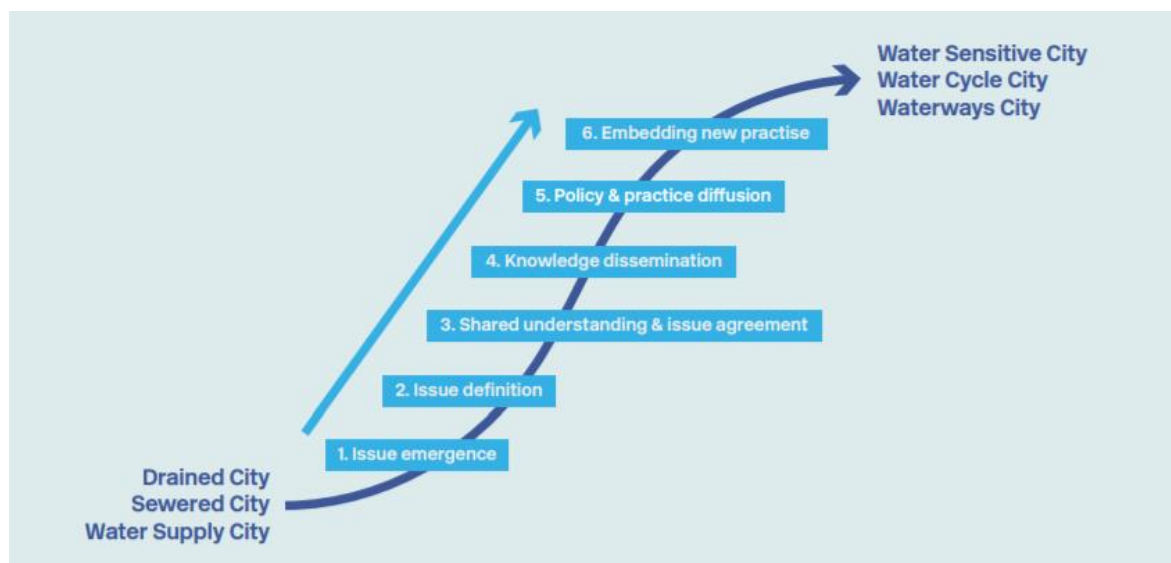

Figure 15: Six phases in the transition toward water sensitivity (Source: Brown et al., 2013, cited in (Brown, Rogers, & Werbeloff, 2016))

Instrumental parameters in each phase advancement are the prevailing narratives, generally speaking separated into proponent and opponent voices, along with the domains of change (Brown, Rogers, & Werbeloff, 2016). The domains of change include the following (Brown, Rogers, & Werbeloff, 2016):

- *Actors,* ideally interacting individually in gradually expanded networks for knowledge and information exchange upon related issues
- *Bridges*, semi formalized or formalized structures and processes that facilitate the collaboration among different domains, for instance among scientists, policy makers and industry, with their form and role changing over time
- *Knowledge*, scientific research for the problems understanding and solutioning, initially based on science and pilot-scale studies, and later engaging more applied investigation

- *Projects*, including experiments and other processes in order to check the performance of new technological proposals and approaches
- *Tools*, including administrative, regulatory, implementation and compliance instruments, for better adoption of new practices
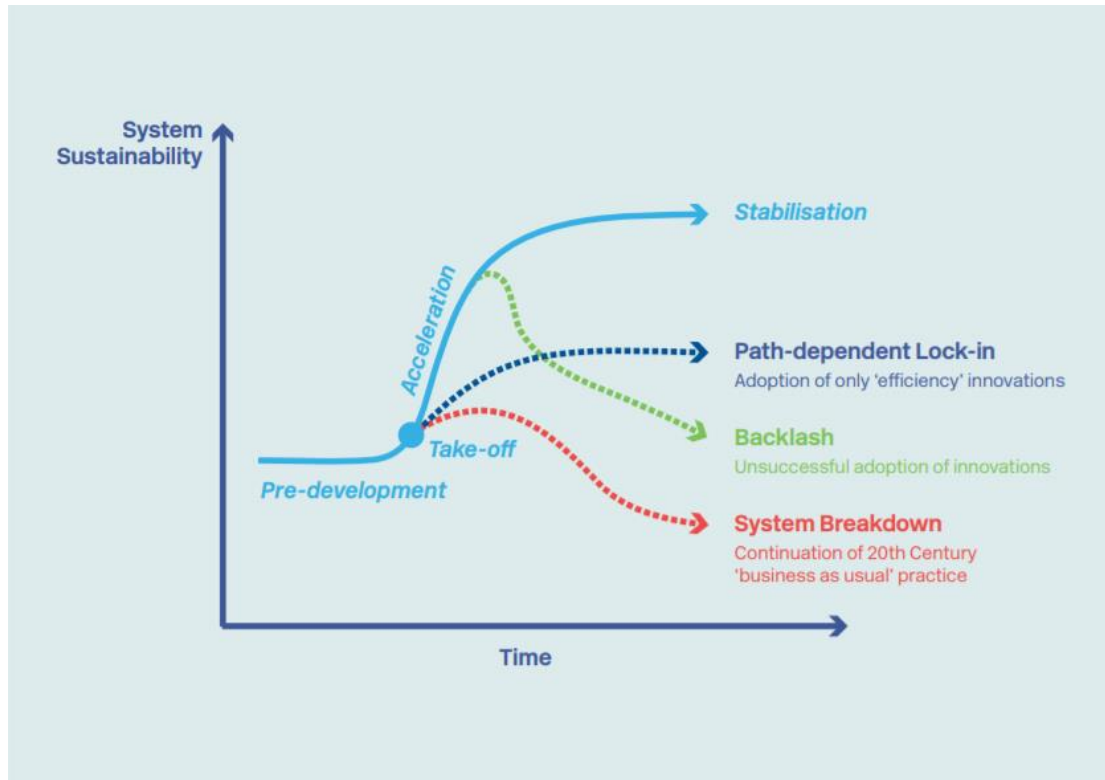

Figure 16: Different transition pathways (Source: Van der Brugge & Rotmans, 2007, cited in (Brown, Rogers, & Werbeloff, 2016))

Figure 16 shows an array of possible paths in the procedure of transition towards more sustainable systems, based on relative studies (Brown, Rogers, & Werbeloff, 2016). The optimal, ideal evolution of a city transition is presented with the S-curve that finishes in a *stabilization* phase, with new socio-technical scheme. However, in real life cases, the progress of the transition may be sub optimal, as it is depicted with the rests of the curves, for example *lock-in, backlash and system breakdown.* (Brown, Rogers, & Werbeloff, 2016). For achieving the best results possible in any case, proper planning, monitoring and financing, as well as engagement are essential (Brown, Rogers, & Werbeloff, 2016).

4.5. Other similar approaches

4.5.1. Smart Cities

Another concept, with similar perception upon the general function of an urban area, regarding to sustainable water resources management and its interconnections to other domain of human activity is this of the Smart City, developed in the EU.

According to EU, a smart city incorporates efficaciously information and communication technologies (ICT) into conversional administration structures and services, such as urban transportation systems, water supply and wastewater utilities, building operations and other, for ameliorating recourses usage and emissions and, finally, urban life. As a result, the city becomes more *responsive* and *interactive*, in the best interests of all citizen and businesses.

Towards to this direction, the European Commission's initiative called ''European innovation partnership on smart cities and communities (EIP-SCC)'' attempts to unite general public, industry, businesses, banks, research and other stakeholders under the umbrella of integrated city governance, for developing sustainable and innovative solutions for given challenges.

For better knowledge exchange and open data, a digital platform has been created (https://eu-smartcities.eu/), where individuals can find news, baselines, tools, guides and blueprints, partners, projects and funding opportunities.

(https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-nitiatives/smart-cities_en)

4.5.2. Water Wise Cities – The IWA Principles

The International Water Association IWA Principles for Water-Wise cities have been designed as a framework towards a sustainable water management in urban areas, encouraging the active participation of local government, stakeholders and citizens as well, both in case of existing assets and future ones, through WSUD. The Principles' structure is based on the following rationales:

- Natural resources are not endless and urban population is increasing, so it is essential their proper use, reuse and renewal in order to do more with less
- Expanded metropolitan areas can be both an advantage in economic prosperity and a handicap in liveability, so the resiliency and the efficiency of the water services is of primary importance
- Many uncertainties, such as climate change and population growth impel the need for better reactive water systems in the future

The structure of the Principles is four levels of action, provided that human rights to safe water and sanitation are fulfilled, along with five building blocks.

The *Four Levels of Action* are:

- ❖ *Level 1 -Regenerate Water Services for all*: The aim of this level is to provide present and future demands, ensuring water quantity and quality by appropriate use of resources, energy and materials in existing and developing systems. It is supported by five principles, as described below:
  - ▪ *Replenish* water bodies and their ecosystem by controlling both intakes from and discharges to them in order to keep up with natural pace of giving and absorbing respectively, and the quality of urban run-offs.
  - ▪ *Reduce the amount of water and energy used*
  - ▪ *Reuse* water according the ''fit-for-purpose'' use approach, *Recover* energy from water, *Recycle* recognizing ''upcycled'' materials, for instance organic matter and nutrients
  - ▪ *Use a Systemic Approach integrated with other services* by adopting a holistic view upon different parts of a water service, for example energy and waste
  - ▪ *Increase the modularity of systems and ensure multiple resource, treatment, storage and conveyance options availab*le for more resilient and safer water systems
- ❖ *Level 2 -Water Sensitive Urban Design*: The aim of this level is to build sensitive, resilient and viable urban water environment through the integration of urban design with water management. It is supported by four principles, as described below:
  - ▪ *Plan and implement urban design enabling regenerative water services* in order to restrict water, energy and carbon impact of housing, lower monthly bills, clean waterways, improve social amenities
  - ▪ *Design urban spaces to reduce flood risks* by constructed urban infrastructure that helps the city reacts as a ''sponge'', with rapid disaster recovery and managing rainwater as a resource
  - ▪ *Enhance liveability with visible water* including roadside green, blue-green corridors, inclusive and multi-purpose public areas, economic transportation
  - ▪ *Modify and adapt urban materials to minimize their impact on water pollution* by adequate use of materials of roads, roofs, and generally urban surfaces
- ❖ *Level 3 -Basin connected cities*: The aim of this level is to enhance the access in water, energy and good supply, to manage flood risks and foster activities between basins and their dependent urban areas. It is supported by three principles, as described below:
  - ▪ *Plan to secure water resources* and mitigate drought by the collaboration of the users of the basin that participate in city and

economy's life, such as individuals, agriculture, industries, energy sector

- *Protect the quality of water resources* including all basin users, in order to attain maximum water quality of potable water with minimum treatment and energy demand
- *Prepare for extreme events* like storms by rivers' system management, suitable vegetation and flood warning systems

❖ *Level 4 -Water-wise communities*: The aim of this level is to encourage the ''water-wise'' transition, both in professionals, in order to incorporate water in other sectors, and in stakeholders and dwellers, so as to understand their key role in water urban design and adjust their behavior. It is supported by five principles, as described below:

- *Empowered citizens* that participate in water-wise agenda by accepting relative solutions and services and are willing to pay for them, while forcing for affordability, because they have comprehended risks and opportunities
- *Professionals with various expertise (finance, technical, social)* aware of co-benefits across sectors, including water management and urban design, landscaping, waste, energy and transport services suggest fitting solutions for all involved parts
- *Transdisciplinary planning and operation teams* that assist the inter-connections between water (fresh, precipitation, sea and rivers, waste) and urban structure (roads, parks, waste, energy) and take them into account in policy-making
- *Policy makers* enabling water-wise action implementing flexible policies and financial tools based on innovative solutions and gradually withdrawing of existing environmentally unfriendly tax advantages
- *Leaders* that engage and engender trust and engagement not only in national but also in local level and across specialties

The *Five Building Blocks to Deliver Sustainable Urban Water*, according this proposal are:

- *Vision* motivates people, stakeholders and governance of every level to work collectively, applying innovative measures and long-term strategies
- *Governance* outlines the action frame for all the involved actors and also gives incentives for co-operation among sectors
- *Knowledge and capacities* either existing or newly developed are prerequisite in the implementation of water-wise city vision
- *Planning tools* used cross-sectorally in order to trigger action, to evaluate risks and benefits, as well as to ensure stakeholder participation and ownership

- *Implementation tools* that create incentives and ensure transparency, equity, accountability, adaptability, innovative spirit and sound financing

As it can be pointed out, the above framework proposed is detailed and include practical steps towards water and urban sustainability.

(IWA)   Retrieved   from   https://iwa-network.org/wp-content/uploads/2016/08/IWA_Brochure_Water_Wise_Cities.pdf

5. Conclusions

All thing considered, the need for a paradigm shift in the current water management practices is unquestionable, due to the environmental, social, political and economic challenges that many places in the world face, which are inevitably related to water resources, every form of which should be considered valuable.

The severity of the problems, as well as the capability of reaction and the progress that has been made so far in the direction of more sustainable practices vary in every region or country, depending on the specific context. In light of this, it is essential to delineate that there are no panaceas or ''one size fits all'' solutions, rather than a range of potential actions and approaches, as it can be proved by the number of concepts that have been mentioned in the present thesis.

Every concept proposed offers a framework for action and general guidelines, but in order to be effective and accepted, it is important to take into account the particular circumstances of every case, avoiding idealizations and thoughtless generalization and imitation of other examples.

It is also important to mention that, besides the limitations and shortcomings that every approach and concept inherently contain, the cost of inaction outweigh the cost of action, in economic, social and environmental terms. The dynamic nature of the continuing changing conditions demand constant control and feedback of the performance of every strategic plan imposed, so as to better adjust to the existing background, optimizing the outcome.

The role of water governance in the effective conceptualization, design, implementation, monitoring and evaluation of every water management plan that brings sustainability and water sensitivity, especially in urban areas is of utmost significance, since good governance may activate, promote and guarantee, among others, the prerequisites:

- Respect of human rights, fairness, accountability, trust, openness
- All-embracing participation and engagement
- Long-term strategic vision
- Sound financing
- Coordination among levels and stakeholders, sharing common values, vocabulary, knowledge and information
- Balance between individual's power and interests and public good
- Balance between economic development and social prosperity and water resources use

In order to motivate change and put into practice principles of good governance and integrated and sustainable water management, so as to finally reach higher levels of

water sensitivity in cities, strong political will and social education and awareness are conditio sine qua non.

As a future work, research on the national and local state water management and governance in Greece is proposed, to determine the current difficulties, practices, limitations and benefits, as well as opportunities, in order to move into higher degree of water sensitivity and sustainability.

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