ASSET MANAGEMENT FOR WATER NETWORKS IN EGYPT BY HYDRAULIC MODELING SIMULATIONS

Abo Alabbas E. Galal[1]; Hosam F. Hendy[2] and Ahmed K. Moawad[1]

1) Dept. of Civil Engineering, Faculty of Engineering, Al-Azhar University, Cairo, Egypt. 2) Planning and Design Sector, Holding Company for Water and Wastewater, Cairo, Egypt.

ABSTRACT

Within the framework of immense plans for water networks renewal in Egypt as a potential solution for Optimized Renewal Plans, this research investigates water network asset management numerically. Basically, previous research in asset management domain were amassed. ***Within the umbrella*** of ***H***olding ***C***ompany for ***W***ater and ***W***astewater "HCWW", 3 areas in 3 governorates were investigated namely; (Damietta [area 1], Gharbia [area 2] and Matrouh [area 3]). "Water GEMS" model was selected, as it offers a renewal plan, which depends on Risk-Score of pipes. "GEMS" was operated where three simulations were achieved to the 3 areas, and pipe break analysis was utilized to incorporate several aspects (i.e., Pipe age, diameter, material, feeding critical customer and criticality). The results indicated that this method could support accurate pipe renewal plans within financial conditions. Results emphasized that the obtained plan can assist decision makers to allocate pipes to be replaced, based on their risk. It was recommended to utilize this methodology to achieve high performance. It was suggested that networks replacement should be based on priorities.

Keywords: Asset Management-Water Network Replacement– Water Gems-Renewal Planner

INTRODUCTION

Pipe ***R***isk ***S***core "PRS" is the multiplication of probability and importance. Accordingly, hydraulic models are desirable tools to assess pipes and their priorities (Zangenehmadar, 2016).

Consequently, many researchers studied PRS in asset management. From the assembled studies (Harvey, 2015), it appeared that ***network asset management process*** is achieved via 4 phases, as follows:

- ***Field inspection:*** This phase determines the network conditions, in terms of leaks and pressures.
- ***Simulation:*** This phase achieves hydraulic analysis and asset management.

- ***Matrix construction:*** This phase constructs a Risk-based Decision-Making matrix.
- ***Execution:*** This phase monitors, maintains, plans the replacement process, colors legend maps, classifies pipes and classifies priorities. (Focusing on the amassed previous studies Curt, *et al.,* 2018).

Infrastructures are essential for maintaining the vital functions of a society, and the health, safety, security, and economic and social well-being of the community. Their inexorable ageing and deterioration lead to significant impacts that become ever more apparent as the demands of society for levels of service, risk management and sustainability increase. Infrastructure Asset Management (IAM) is essential for efficiently maintaining, operating and renewing infra-structures, and thus lowering risk and impacts (Alegre, *et al.,* 2012). IAM allows infrastructures to deliver a certain level of ser-vice in a cost-effective manner in both the short and long-terms, with the service function depending on the infrastructure considered: supplying water, protecting against floods, collecting wastewater, transport and so forth. Utility managers need to structure their IAM approaches to ensure the sustainable and efficient management of their systems: environmental, economic, social and technical criteria must be considered.

This calls for integrated IAM rules and strategies to mitigate it was obvious that the ***asset management benefits*** achieve the following (Water utility asset management, a guide for development practitioners, Asian Development Bank):

- Optimizes the needed budget for the pipes network replacement.
- Enhances the operational decisions.
- Improves emergency response.
- Plans and pays future replacements so as repair
- Increases the knowledge of assets allocations.
- Increased knowledge of what assets are critical to the utilities.
- Promotes customers communications.
- Enhances operational information.
- Promotes the projects capitals to meet the system actual needs.

Converging on the scrutinized previous investigation, the following is obvious:

- Asset Management of networks is achieved by Hydraulic Modeling, as it is considered as a potential solution for network renewal plans optimization.
- Renewal plans depend on risk score so as probability and importance of each pipe.
- Holding company for water and Wastewater Company supervise the hydraulic analysis models.
- Pipe break analysis depends on criticality, pipe age, pipe diameter, pipe material and pipe feeding critical customer.
- Pipes are classified according to their risk. Accordingly, they can be implemented in minimizing their cost, their performance and their strategy so as risk management.

In Egypt, especially Housing and Utilities Ministry, Holding Company for Water and Waste Water, apparent was that there is an immense effort in the context of rehabilitating water networks in Egypt, as an effective plan for optimizing the renewal.

Accordingly, this research was commenced with the aspiration of simulating water network asset management, numerically. Consequently, a research methodology was designed to encompass 4 actions (i.e., Field Inspection, Numerical Inspection, Analytical Inspection and Inferential Inspection) that are presented, as follows (A Guide To Asset Management For Small Water Systems, 2015).

FIELD INSPECTION

During this stage, site visits were executed to the 3 areas (i.e., Gharbia, Damietta and Matrouh). Data was assembled and analyzed, from which criticality variables were proposed; weights were assigned to each and aspects weights were proposed (Belmeziti, *et al.*, 2015).

In addition, the analyzed data revealed that a task was assigned to the 3 areas by the WWHC that was achieved by representatives of the ***H***ydraulic ***A***nalysis ***D***epartment "HA-D", ***GIS D***epartment "GIS-D, ***O***peration And ***M***aintenance ***S***ector "OMS" and ***A***sset ***M***anagement ***D***epartment "AM-D".

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

These representatives selected pilot project area. In addition, they assigned variables of criticality (Cardoso, et al., 2012) and (Shaw, et al., 2012).

Field inspection for Gharbia (area 1)

During field visits in Gharbia (Area 1), data was amassed and scrutinized, from which clear was the following:

- Gharbia case study is in El-Mahala City.
- It has 335 km water network.
- The network serves 235000 capita.

During field visits in Gharbia case study, criticality variables were proposed; weights were assigned to each and aspects weights were proposed; tables (1) to (3).

Table (1): Proposed criticality variables (Area 1)

S.N	CRITICALITY VARIABLE	UNITS	DESCRIPTION	CATEGORY
1	PD	mm	Large pipes are more important and need more time so as money for fixation.	Economic
2	PM	Domain	Some materials fail catastrophically and need more time as well as money to be fixed	Economic
3	RT	Domain	Affect traffic	Social
4	NRL	No.	Used as a substitute for heavy traffic	Social
5	Soil Type	Domain	Affects repair time and cost and affects pipes failure by cracks	Environment
6	SCC	(Yes/No)	Identify hospitals, schools, and other facilities impacted by water outages	Social
7	PBA	No./km/year	At pipe break, the probability to failure increases	Economic
8	C	No.	Isolated pipes have higher criticality	Social

PD: Pipe Diameter
PM: Pipe Material
RT: Road Type
NRL: Number of road lanes
ST: Soil Type
SCC: Serving Critical Customer
PBA: Pipe Breaks Analysis
C: Criticality

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Table (2): Proposed criticality variables weights (Area 1)

PIPE MATERIAL	
Type	**Weight**
Asbestos Cement	100
GRP	100
PVC	50
UPVC	50
Cast Iron	30
Ductile Iron	20
Steel	20
Concrete	10
Pipe Diameter	
Diameter	**Weight**
100	10
150	15
200	20
250	25
300	30
400	40
450	45
500	50
600	60
➢ 600	100
Serving critical customer	
Type	**Weight**
Yes	100
No	0

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Cont. Table (2):

ROAD TYPE	
Type	**Weight**
local	1
collector	5
Minor arterial	10
Major arterial	50
Free way	100
Soil Type	
Type	**Weight**
Clay	1
Sand	10
Collapsing	100
Acidic soil	100
Pipe crossing	
Type	**Weight**
No crossing	0
Surface crossing	10
Sub surface crossing	20

Table (3): Proposed aspects weights (Area 1)

ASPECT	WEIGHT (%)
Pipe Break Analysis	30
Criticality	34
Pipe Diameter	8
Pipe Material	5
Soil Type	5
Road Type	5
Number of Road Lanes	3
Serving Critical Customer	10
Total	**100**

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Field inspection for Damietta (area 2)

During the field visits in Damietta (Area 2), data was assembled and analyzed, from which obvious was the following:

- This pilot area is located east of Nile Zone in Damietta City.
- Its water network is 190 km long.
- It serves 105000 capita.

During field visits in Damietta case study, criticality variables were suggested;weights were allocated to each and aspects weights were anticipated; tables (4) to (6).

Table (4): Proposed criticality variables (Area 2)

S.N	CRITICALITY VARIABLE	UNITS	DESCRIPTION	CATEGORY
1	Pipe-Diameter	Mm	Large pipe consumes extra time and money and are more important.	Economic
2	Pipe-Material	Domain	Some materials consume extra time and money and fail tragically	Economic
3	Road-Type	Domain	Affects traffic operations	Social
4	Number-road-lanes	No.	Is a traffic volume proxy	Social
5	Soil-Type	Domain	affects repair time and cost and leads to failure by cracks	Environment
6	Serving-Critical-Customer	(Yes/No)	Recognize industrial facilities and administrative buildings, affected by water outages	Social
7	Pipe-Breaks- Analysis	No./km/year	If the pipes break probability failure increases	Economic
8	Criticality	No.	Pipe isolation is critical	Social
9	Operational-Flag	(Yes/No)	Pipes are flagged o indicate a problem in maintenance	Economic

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Table (5): Proposed criticality variables weights (Area 2)

PIPE MATERIAL	
Type	**Weight**
Asbestos Cement	100
GRP	100
PVC	50
UPVC	50
Cast Iron	30
Ductile Iron	20
Steel	20
Concrete	10
Pipe Diameter	
Diameter	**Weight**
100	10
150	15
200	20
250	25
300	30
400	40
450	45
500	50
600	60
➢ 600	100
Serving critical customer	
Type	**Weight**
Yes	100
No	0

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Cont.Table (5):

PIPE MATERIAL	
Road Type	
Type	**Weight**
local	1
collector	5
Minor arterial	10
Major arterial	50
Free way	100
Soil Type	
Type	**Weight**
Clay	1
Sand	10
Collapsing	100
Acidic soil	100
Pipe crossing	
Type	**Weight**
No crossing	0
Surface crossing	10
Sub surface crossing	20
Operational Flag	
Type	**Weight**
Yes	100
No	0

Table (6) Proposed aspects weights (Area 2)

ASPECT	WEIGHT (%)
Pipe Break Analysis	25
Criticality	35
Pipe Diameter	8
Pipe Material	5
Soil Type	5
Road Type	5
Number of Road Lanes	3
Serving Critical Customer	7
Operational Flag	7
Total	**100**

Field inspection for Matrouh (area 3)

During the field inspection in Matrouh (Area 3), data was accumulated and examined, from which remarkable was the following:

- The pilot area is located in Haggag Ali Destrict in Marsa Matrouh City.
- Its water network is 19.7 km long with different diameters (i.e. 100, 150, 200, 250, 300 mm) with different materials (i.e. UPVC, Asbestos Cement, and Steel).

During field visits in Mattrouh case study, criticality variables were planned; weights were apportioned to each and aspects weights were projected; tables (7) to (9).

Table (7) Proposed criticality variables (Area 3)

S.N	CRITICALITY VARIABLE	UNITS	DESCRIPTION	CATEGORY
1	PD	mm	Large pipes are more important and need more time so as money for fixation.	Economic
2	PM	Domain	Some materials fail catastrophically and need more time as well as money to be fixed	Economic
3	SCC	(Yes/No)	Identify hospitals, schools, and other facilities impacted by water outages	Social
4	PBA	No./km/year	At pipe break, the probability to failure increases	Economic
5	C	No.	Isolated pipes have higher criticality	Social

PD: Pipe Diameter
PM: Pipe Material
SCC: Serving Critical Customer
PBA: Pipe Breaks Analysis
C: Criticality

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Table (8): Proposed criticality variables weights (Area 3)

PIPE MATERIAL	
Type	**Weight**
Asbestos Cement	100
UPVC	50
Steel	10
Pipe Diameter	
Diameter	**Weight**
100	40
150	60
200	60
250	70
300	100
Serving critical customer	
Type	**Weight**
Yes	100
No	0

Table (9): Proposed aspects weights (Area 3)

ASPECT	WEIGHT (%)
Pipe Break Analysis	20
Criticality	20
Pipe Diameter	25
Pipe Material	25
Serving Critical Customer	10
Total	**100**

NUMERICAL INSPECTION*:*

In this stage, "GEMS" program was employed to classify pipes in the selected areas according to their risk score and probability scores for their pipe break were designated (Bambara, et al.,2018). GEM was tooled to divide the network into segments and assigned criticality score for each pipe, based on the impact of each pipe, in terms of its isolation. GEM designated the nodes that are affected by pressure shortage and flow shortage. AHP method was implemented in pipe renewal planner to calculate each pipe risk score by determining weights of all aspects, where the weight summation is 100%.

It is worthwhile to mention that the WWHC representatives of HA-D, GIS-D, OMS and AM-D completed GIS data to update the hydraulic model. Additionally, the representatives planned workshops with Operating and Maintenance staff (O&M staff) experienced in operating and maintaining the facilities to assemble input data to the model . Moreover, they ran the model by utilizing the criticality calculator. Furthermore, they developed GIS criticality maps for the 3 areas and organized workshops for model review so as model validation.

Nnumerical inspection for Gharbia (area 1)

Within numerical inspection, Water GEMS simulated ***P***ipe ***R***isk ***S***core "PRS" for area 1 and a color-coding map was produced to the pipe risk score; figure (1) & table (10).

Table (10): Pipe Risk Score using Water GEMS (Area 1)

Label	Pipe Score	Score pipe break analysis	Score Criticality	Score Diameter	Material	Score Material	No. of road lanes	Score no. of road lanes	Road Type	Score Road Type	Serving critical customer	Score serving critical customer	Soil Type	Score Soil Type
P-669	57	1	100	100	concrete	100	2	1	local	1	yes	100	clay	1
P-738	55	1	100	100	steel	50	2	1	local	1	yes	100	clay	1
P-3382	55	1	100	100	steel	50	2	1	local	1	yes	100	clay	1
P-3383	55	1	100	100	steel	50	2	1	local	1	yes	100	clay	1
P-618	54	1	100	25	cast iron	60	2	1	local	1	yes	100	collaps	100
P-3377	46	1	100	100	ductile iron	80	2	1	0	0	0	0	0	0
P-3378	46	1	100	100	ductile iron	80	2	1	0	0	0	0	0	0
P-3384	46	1	100	100	ductile iron	80	2	1	0	0	0	0	0	0
P-3262	46	1	100	100	ductile iron	80	0	0	0	0	0	0	0	0
P-3268	46	1	100	100	ductile iron	80	0	0	0	0	0	0	0	0
P-3274	46	1	100	100	ductile iron	80	0	0	0	0	0	0	0	0
P-3279	43	1	100	100	ductile iron	80	0	0	0	0	0	0	0	0
P-3280	43	1	100	100	ductile iron	80	0	0	0	0	0	0	0	0
P-3334	43	1	100	100	ductile iron	80	0	0	0	0	0	0	0	0
P-92	43	1	100	100	asbestos cemet	20	0	0	0	0	0	0	0	0
P-1141	43	1	100	100	asbestos cemet	20	0	0	0	0	0	0	0	0
P-2059	43	1	100	100	asbestos cemet	20	0	0	0	0	0	0	0	0
P-2060	43	1	100	100	asbestos cemet	20	0	0	0	0	0	0	0	0
P-2422	42	100	0	25	asbestos cemet	20	2	1	local	1	yes	100	clay	1
P-271	42	1	100	25	asbestos cemet	20	2	1	colctive	5	no	1	collaps	100
P-933	42	1	100	25	asbestos cemet	20	2	1	colctive	5	no	1	collaps	100
P-3187	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3191	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3193	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3197	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3199	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3200	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3202	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3203	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3210	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0
P-3212	42	1	100	50	ductile iron	80	2	1	0	0	0	0	0	0

Figure (1): Map showing pipe risk score color coding (Area 1)

Numerical inspection for Damietta (area 2)

All through numerical inspection phase, Water GEMS simulated PRS for area 2 and a CCM was obtained to the pipe risk score; figure (2) and table (11).

Table (11): Pipe Risk Score using Water GEMS (Area 2)

Label	Pipe Score	Score Pipe Break Analysis	Score Criticality	Soil Type	Score Soil Type	Diameter	Score Diameter	Material	Score Material	Road Type	Score road type	No. of road lanes	Score of no. of road lanes	Serving critical customer	Score of serving critical customer	Operational flag	Score operational flag
P-1140	76	100	80	collaps	100	200	25	Asbestos cement	20	collector	5	3	10	yes	100	yes	100
P-1210	70	100	80		0	150	20	Asbestos cement	20	local	1	2	1	yes	100	yes	100
P-1230	70	100	80		0	100	20	Asbestos cement	20	local	1	2	1	yes	100	yes	100
P-1170	69	100	100	clay	1	150	20	PVC	1	local	1	2	1	yes	100	no	1
P-1180	69	100	100	clay	1	100	20	PVC	1	local	1	2	1	yes	100	no	1
P-1200	69	100	100	clay	1	100	20	PVC	1	local	1	2	1	yes	100	no	1
P-1201	64	80	100	clay	1	200	25	PVC	1	local	1	2	1	yes	100	no	1
P-1230	63	100	80	clay	1	100	20	Asbestos cement	20	local	1	2	1	no	1	yes	100
/ater - P-	63	100	80		0	100	20	Asbestos cement	20	local	1	2	1	no	1	yes	100
/ater - P-	63	100	80		0	100	20	Asbestos cement	20	local	1	2	1	no	1	yes	100
Vater-P-:	63	100	80		0	100	20	Asbestos cement	20	local	1	2	1	no	1	yes	100

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

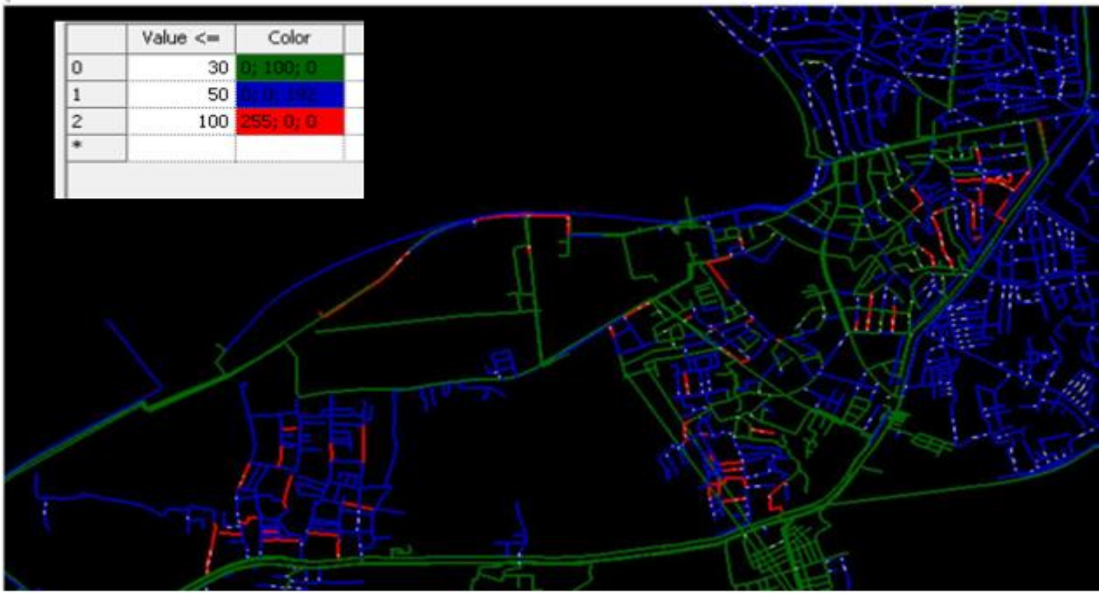

Figure (2): Map showing pipe risk score color coding (Area 2)

Numerical inspection for Matrouh (area 3)

Throughout numerical inspection, GEMS simulated ***P***ipe ***R***isk ***S***core for area 3 was obtained to the pipe risk score; table (12).

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Table (12): Pipe Risk Score using Water GEMS (Area 3)

Label	Pipe Score	Score Pipe Break Analysis	Score Criticality	Diameter	Score Diameter	Material	Score Material	Serving critical customer	Score serving critical customer
30	40	0	100	150	60	PVC	50	no	0
33	40	0	100	150	60	PVC	50	no	0
36	40	0	100	150	60	PVC	50	no	0
39	60	0	100	150	60	Asbestos cement	100	no	0
42	40	0	100	100	40	PVC	50	no	0
45	30	0	52	100	40	PVC	50	no	0
49	60	100	100	100	40	PVC	50	no	0
54	60	0	100	150	60	Asbestos cement	100	no	0
57	65	77	100	150	60	PVC	50	no	0
60	60	0	100	150	60	Asbestos cement	100	no	0
62	30	0	52	100	40	PVC	50	no	0
64	40	0	100	100	40	PVC	50	no	0
67	40	0	100	100	40	PVC	50	no	0
70	60	0	100	150	60	Asbestos cement	100	no	0
72	60	0	100	150	60	Asbestos cement	100	no	0
75	60	0	100	150	60	Asbestos cement	100	no	0
77	60	0	100	150	60	Asbestos cement	100	no	0
79	50	17	100	150	60	PVC	50	no	0
81	60	0	100	150	60	Asbestos cement	100	no	0
82	60	0	100	150	60	Asbestos cement	100	no	0
90	60	0	100	100	40	Asbestos cement	100	no	0
92	30	0	52	100	40	PVC	50	no	0
95	40	0	100	100	40	PVC	50	no	0
98	40	0	100	100	40	PVC	50	no	0
100	60	0	100	150	60	Asbestos cement	100	no	0
101	60	0	100	150	60	Asbestos cement	100	no	0
106	60	0	100	150	60	Asbestos cement	100	no	0
108	30	0	100	100	40	PVC	50	no	0
110	40	0	100	150	60	Asbestos cement	100	no	0
112	40	0	100	100	40	Asbestos cement	100	no	0
118	60	0	52	150	60	PVC	50	no	0
120	60	0	100	150	60	Asbestos cement	100	no	0
123	60	0	100	100	40	Asbestos cement	100	no	0
125	40	0	100	100	40	PVC	50	no	0
128	60	0	100	250	100	PVC	50	no	0
131	60	0	100	100	40	Asbestos cement	100	no	0
133	30	0	100	150	60	PVC	50	no	0
138	60	25	100	150	60	Asbestos cement	100	no	0
139	60	0	100	100	40	Asbestos cement	100	no	0
142	40	0	100	100	40	PVC	50	no	0
145	40	0	100	100	40	PVC	50	no	0
148	60	0	100	100	40	Asbestos cement	100	no	0
150	66	32	100	150	60	Asbestos cement	100	no	0

ANALYTICAL INSPECTION:

In this stage, the obtained results of GEMS were analyzed, from which the network pipes were classified into categories based on risk score (Curt, *et al.*, 2010) and (Sharp, *et al.*, 2013). In addition, a ***F***inal ***P***riorities for ***R***eplacement ***M***ap "FPRM" was produced to allocate the pipes to be renewed, based on asset management (Rozan, *et al.*, 2017).

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Analytical inspection for Gharbia (area 1)

During the analytical inspection, network pipes were classified; figure (3) and a FPRM was obtained for area 1; figure (4).

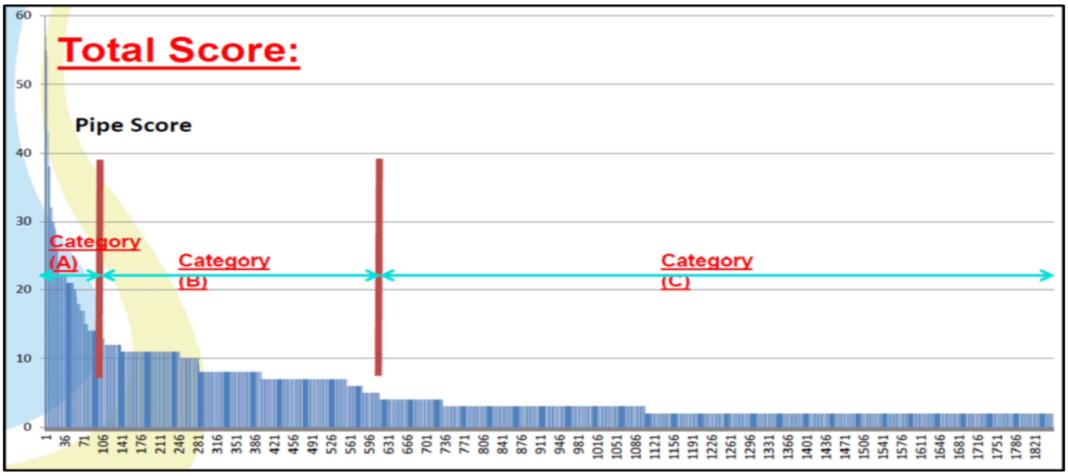

Figure (3): Network pipes risk score categories (Area 1)

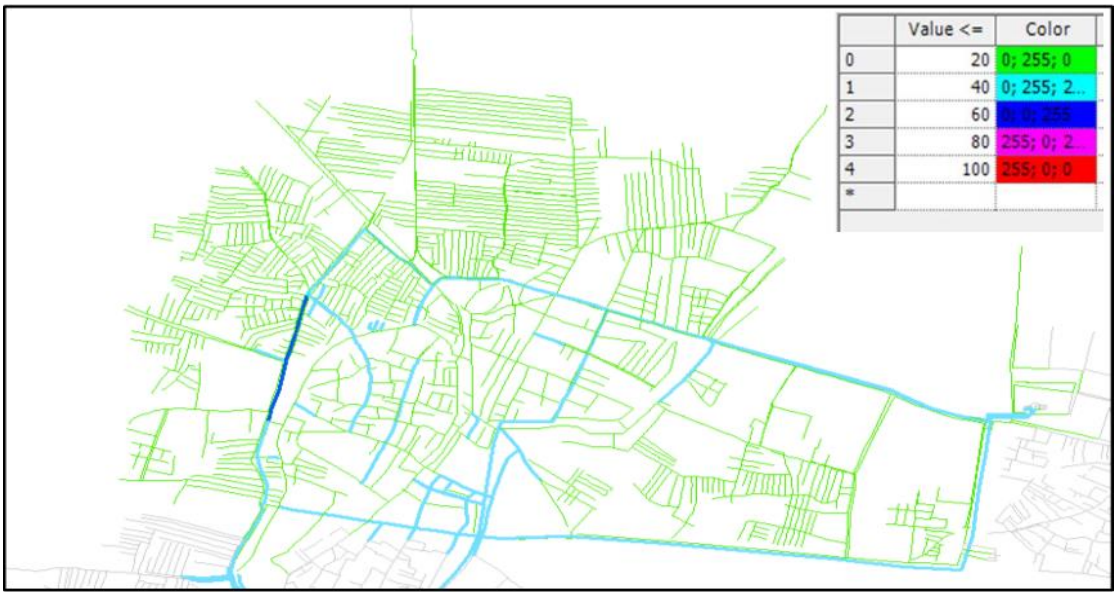

Figure (4): Map for replacement priorities based on asset management (Area 1)

Analytical inspection for Damietta (area 2)

All through analytical inspection, network pipes were categorized; figure (5), and a Final Priorities and Replacement Map was obtained for area 2; figure (6).

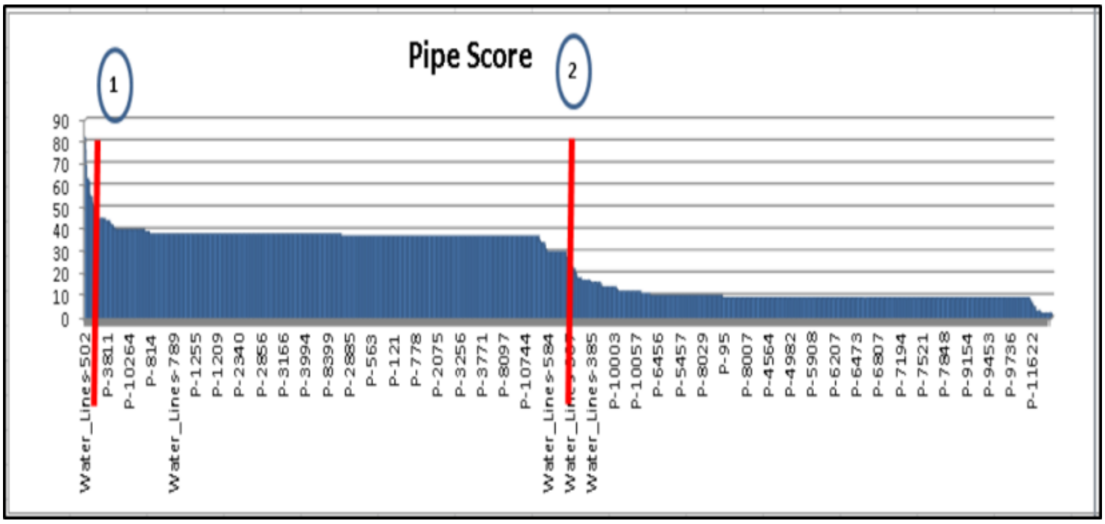

Figure (5): Network pipes risk score categories (Area 2)

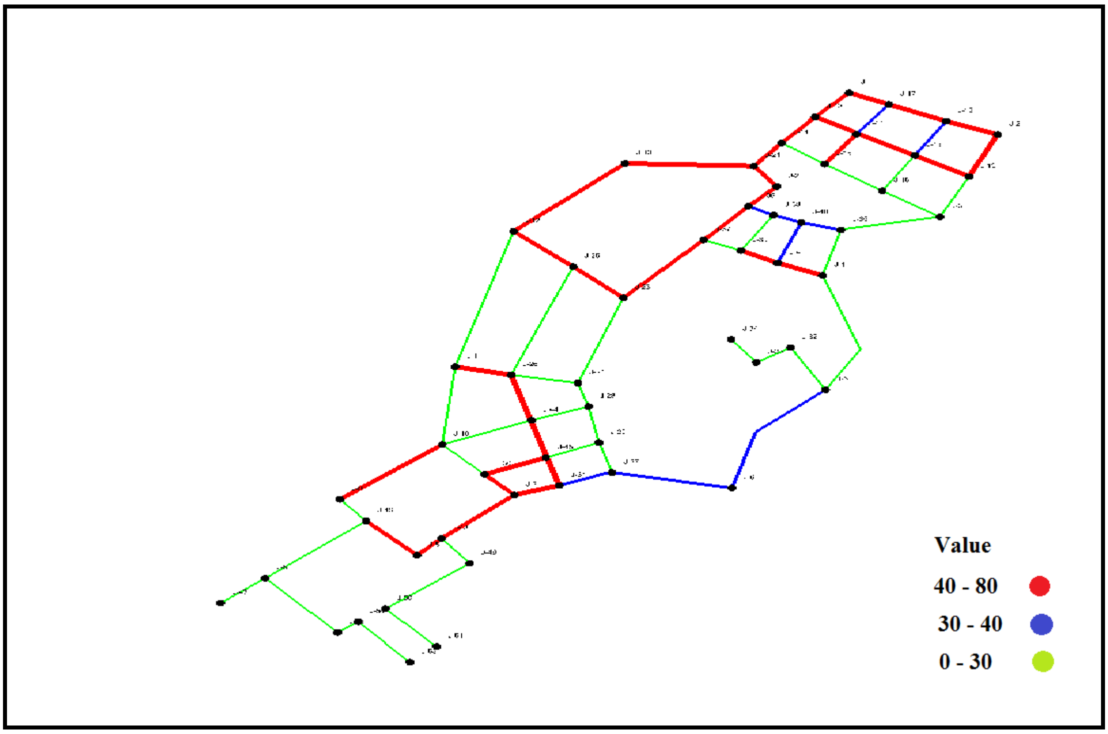

Figure (6): Map for replacement priorities based on asset management (Area 2)

Vol. (52); Iss. (3); No. (6); March 2023
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

Analytical inspection for Matrouh (area 3):

In the analytical inspection, network pipes were categorized and a FPRM was produced for area 3; figure (7).

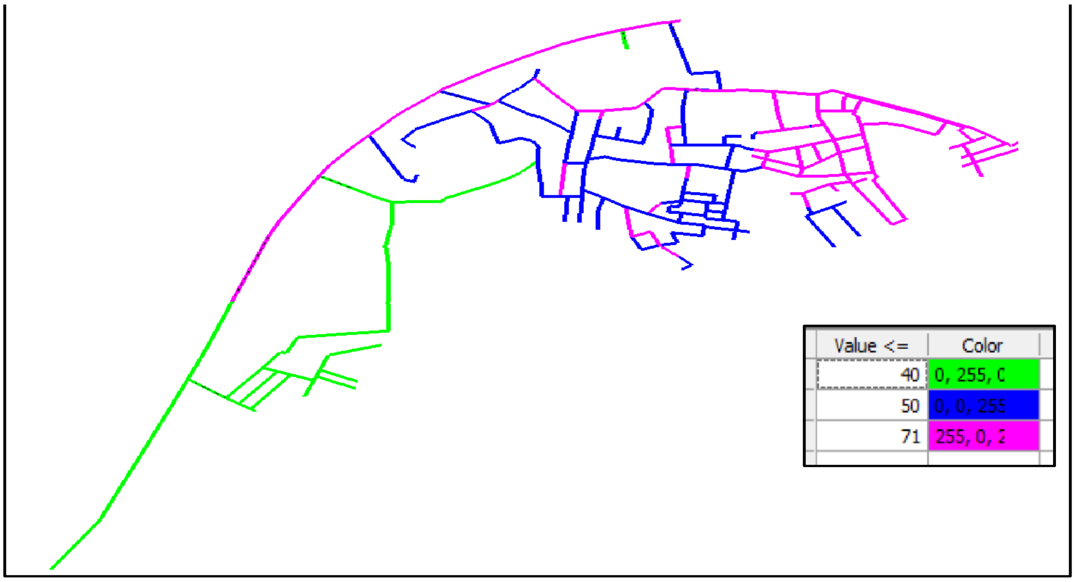

Figure (7): Map for replacement priorities based on asset management (Area 3)

CONCLUSIONS AND RECOMMENDATIONS

Based on the analytical inspection, the following conclusions were deduced:

- The results indicated that this method could support accurate pipe renewal plans to meet limited financial condition.
- Results emphasized that the obtained integrated plan will assist decision makers to allocate pipes to be replaced, based on their risk.
- For areas 1, 2 and 3, the results highlighted the network replacement priorities based on PRS within the available budget.
- For areas 1, 2 and 3, the replacement high priority category pipe networks will achieve maximum benefits from planning available budget.

Based on the deduced conclusions, the following recommendations were suggested:

- It was recommended to utilize this methodology to reduce costs and achieve high performance and safety.
- It was suggested that networks replacement should be based on priorities.

- The present methodology could be replicated for other networks in Egypt.

REFERENCES

Alegre, H., Covas, D. C., Coelho, S. T., Almeida, C. and Cardoso, M. A. (2012), an integrated approach for infrastructure asset management of urban water systems. Water Asset Management International, 8:10-14.

Bambara, G., Curt, C., Mériaux, P., Vennetier, M. and Vanloot, P. (2018), Modular assessment of the performance of embankment dams, European Journal of Environmental and Civil Engineering, 22: 315-337.

Belmeziti, A., Cherqui, F., Tourne, A., Granger, D., Werey, C., Le Gauffre, P. and Chocat, B. (2015), transitioning to sustainable urban water management systems: how to define expected service functions? Civil Engineering and Environmental Systems, 32: 316-334.

Cardoso, M. A., Santos Silva, M., Coelho, T., Almeida, C. and Covas, D. I. C. (2012), Urban water infrastructure asset management - a structured approach in four water utilities, Water Science & Technology, 66: 2702-2711.

Curt, C., Peyras, L. and Boissier, D. (2010), A knowledge formalization and aggregation-based method for the assessment of dam performance, Computer-aided Civil and Infrastructure Engineering, 25: 171-184.

Curt, C.: Tourment, R.: Le Gat, Yves: Werey, C. Asset management of water and sewer networks, and levees: recent approaches and current considerations. The Sixth International Symposium on Life-Cycle Civil Engineering (IALCCE), Oct 2018, Ghent, Belgium. Pp.659-666. ffhal-01951181f

GPWA (Georgia Association of Water Professionals), Asset Management Committee JULY (2015), "A Guide to Asset Management for Small Water Systems".

Rozan, A., Rulleau, B. and Werey, C. (2017), Assessing preferences for sewer network asset management in France, International Journal of Environmental Engineering, 20: 163-182.

Harvey, R (2015), An Introduction to Asset Management Tools Municipal Water, Wastewater and Storm water Systems, A white paper prepared for the Canadian Water Network research project: "An Integrated Risk Management Framework for Municipal Water Systems".

Sharp, M., Wallis, M., Deniaud, F., Hersch-Burdik, R., Tourment, R., Matheu, E., Seda-Sanabria, Y., Wersching, S., Veylon, G., Durand, E., Smith, P., Forbis, J. and Spliethoff, C. (2013), the International Levee Handbook.

Shaw, G., Kenny, J., Kumar, A., and Hood, D. (2012). Sustainable infrastructure operations: a review of assessment schemes and decision support. In Proceedings of the 25th Australian Road Research Board Conference (pp. 1-18). Australian Road Research Board (ARRB).

Water utility asset management, a guide for development practitioners, Asian Development Bank, (2013).

Zangenehmadar, Z (2016) Asset Management Tools for Sustainable Water Distribution Networks, A Thesis in the Department of Building, Civil and Environmental Engineering, Concordia University, Montreal, Quebec, Canada.

إدارة الأصول لشبكات المياه في مصر
عن طريق محاكاة النمذجة الهيدروليكية

ابو العباس عيسي جلال [١]– حسام الدين فوزي ابراهيم هندي [٢]– أحمد كمال معوض [١]

١) قسم الهندسة المدنية بكلية الهندسة، جامعة الازهر بالقاهرة، جمهورية مصر العربية ٢) قطاع التخطيط والتصميم بالشركة القابضة لمياه الشرب والصرف الصحي، القاهرة، جمهورية مصر العربية

المستخلص

في إطار الخطط الهائلة لتجديد شبكات المياه في مصر كحل محتمل لخطط التجديد الأمثل، يبحث هذا البحث في إدارة أصول شبكة المياه رقميا. في الأساس، تم جمع الأبحاث السابقة في مجال إدارة الأصول ضمن مظلة الشركة القابضة لمياه الشرب والصرف الصحي "HCWW" ، تم دراسة ٣ مناطق في ٣ محافظات وهي: (دمياط [منطقة ١] والغربية [منطقة ٢] ومطروح [منطقة ٣]). تم اختيار نموذج "Water GEMS"، حيث يقدم خطة تجديد ، والتي تعتمد على درجة مخاطر مواسير شبكات مياة الشرب. تم تشغيل "GEMS" حيث تم إجراء ثلاث نماذج محاكاة للمناطق الثلاثة، وتم استخدام تحليل كسورات المواسير وتم دمج العديد من المعايير الاخري (على سبيل المثال، عمر المواسير، القطر، مادة الصنع، تغذية العملاء المهمين ودرجةالحرجية). أشارت النتائج إلى أن هذه الطريقة يمكن أن تدعم خطط تجديد مواسير شبكات مياه الشرب الدقيقة في ظل الظروف المالية. وأكدت النتائج أن الخطة التي تم الحصول عليها يمكن أن تساعد متخذي القرار في تخصيص وتحديد المواسير المراد استبدالها، بناءً على المخاطر التي يتعرضون لها. يوصى باستخدام هذه المنهجية لتحقيق أداء عالٍ. واقتراح أن يستند استبدال وتجديد الشبكات على الأولويات الناتجة من المحاكاة.

الكلمات المفتاحية: إدارة الاصول – احلال شبكات المياه – برنامج ووتر جيمس (Water GEMS) – مخطط تجديد المواسير (Renewal Planner)