# METODOLOGÍAS PARA LA DETERMINACIÓN DE MODELOS DE CALIDAD DE AGUA EN LOS RÍOS

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# ÍNDICE



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# 1. MODELAMIENTO MATEMÁTICO

- **1.1. Definiciones**

El modelado matemático es el arte de traducir problemas de un área de aplicación en formulaciones matemáticas manejables cuyo análisis teórico y numérico proporciona información, respuestas y orientación útil para la aplicación de origen (**Arnold Neumaier).**

Los modelos describen nuestras creencias sobre el funcionamiento del mundo. En la modelización matemática, traducimos esas creencias al lenguaje de las matemáticas **(Glenn Marion).**

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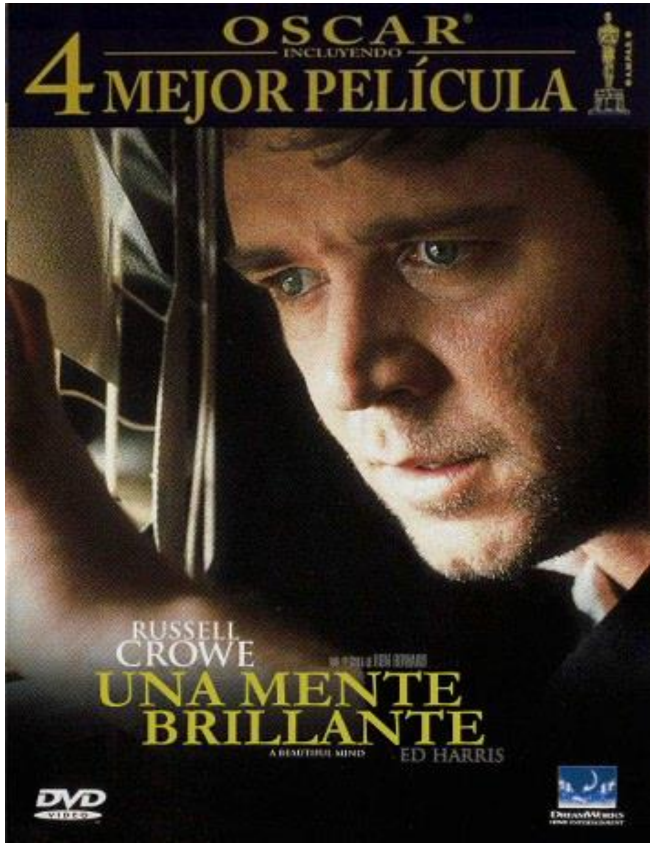


**UNA MENTE BRILLANTE:**

El personaje principal es John Nash, matemático ganador de un Premio Nobel Economía 1994.

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## 1.2. Estructura

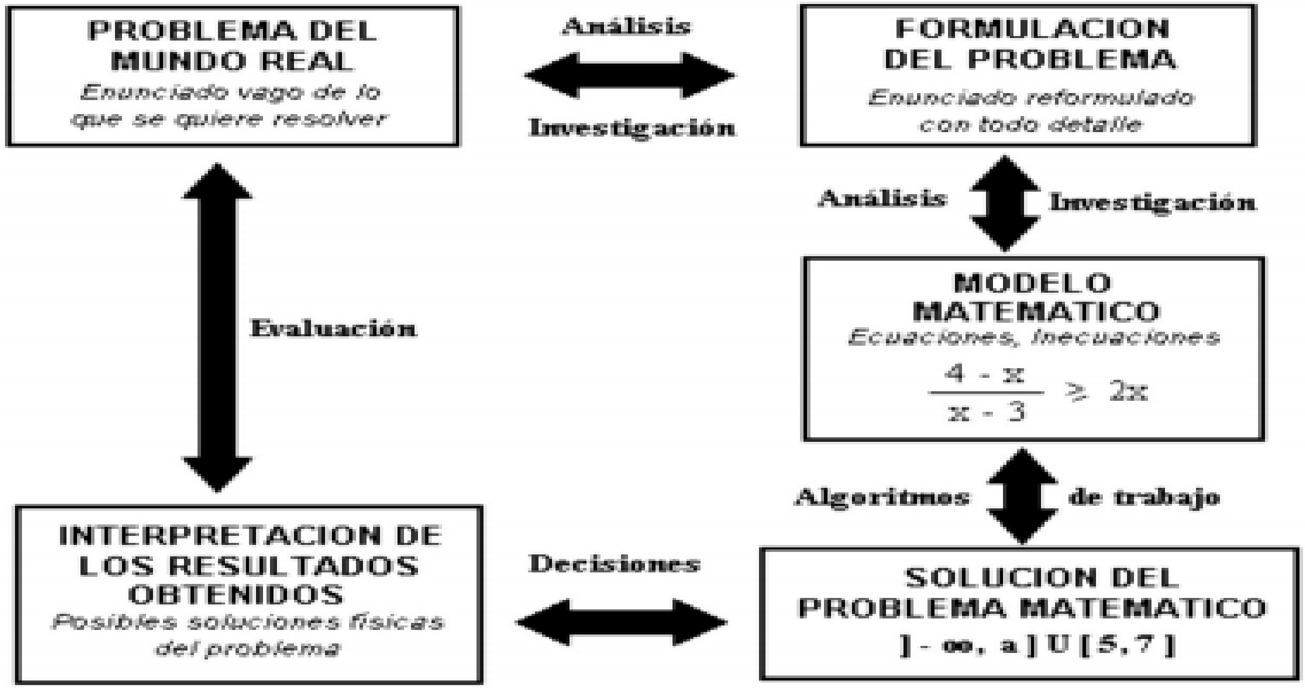


Figura 1. Estructura de un modelo matemático propuesto por Arcos.

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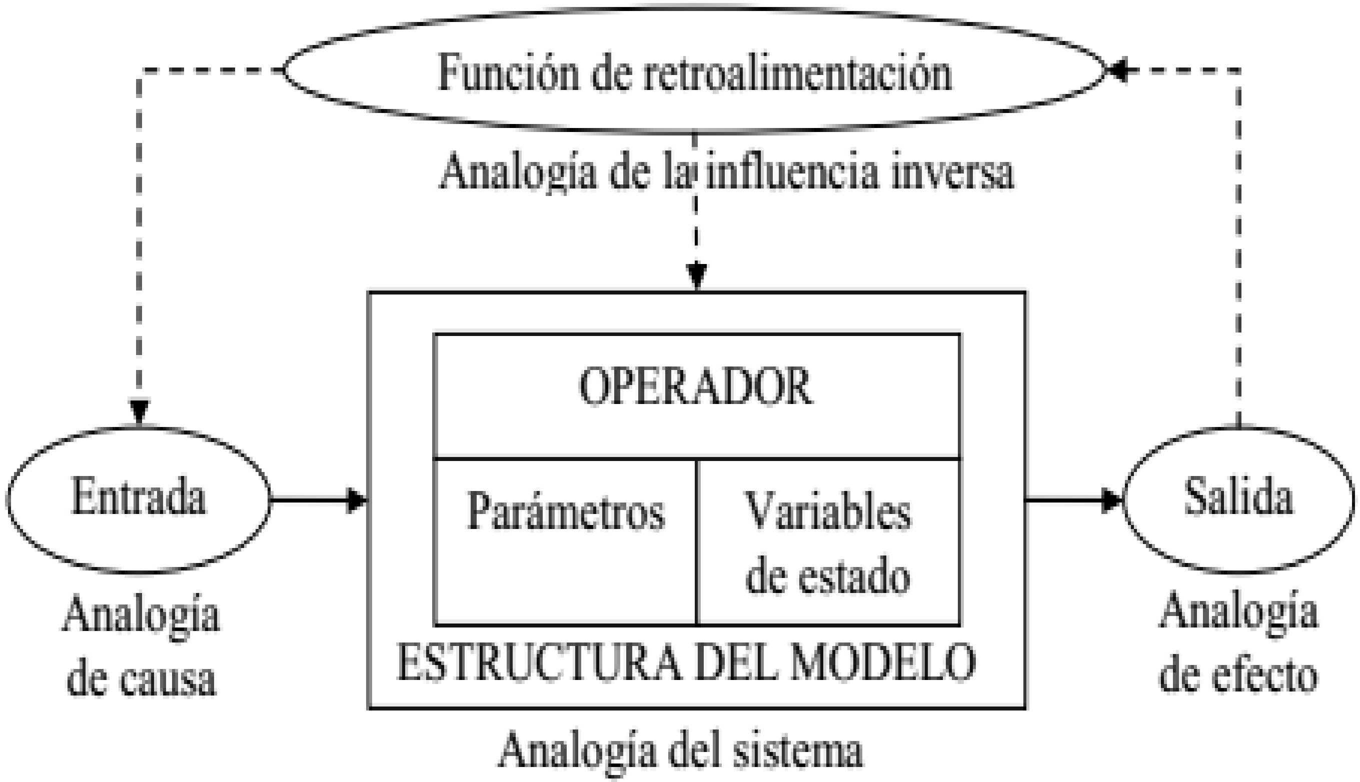


Figura2.- Estructura de un modelo matemático, propuesto por Dominguez.

# MSC2020-Mathematics Subject Classification System

### Associate Editors of Mathematical Reviews and zbMATH

**00** General and overarching topics; collections
**01** History and biography
**03** Mathematical logic and foundations
**05** Combinatorics
**06** Order, lattices, ordered algebraic structures
**08** General algebraic systems
**11** Number theory
**12** Field theory and polynomials
**13** Commutative algebra
**14** Algebraic geometry
**15** Linear and multilinear algebra; matrix theory
**16** Associative rings and algebras
**17** Nonassociative rings and algebras
**18** Category theory; homological algebra
**19** $K$-theory
**20** Group theory and generalizations
**22** Topological groups, Lie groups
**26** Real functions
**28** Measure and integration
**30** Functions of a complex variable
**31** Potential theory
**32** Several complex variables and analytic spaces
**33** Special functions
**34** Ordinary differential equations
**35** Partial differential equations
**37** Dynamical systems and ergodic theory
**39** Difference and functional equations
**40** Sequences, series, summability
**41** Approximations and expansions
**42** Harmonic analysis on Euclidean spaces
**43** Abstract harmonic analysis
**44** Integral transforms, operational calculus
**45** Integral equations
**46** Functional analysis
**47** Operator theory
**49** Calculus of variations and optimal control; optimization
**51** Geometry
**52** Convex and discrete geometry
**53** Differential geometry
**54** General topology
**55** Algebraic topology
**57** Manifolds and cell complexes
**58** Global analysis, analysis on manifolds
**60** Probability theory and stochastic processes
**62** Statistics
**65** Numerical analysis
**68** Computer science
**70** Mechanics of particles and systems
**74** Mechanics of deformable solids
**76** Fluid mechanics
**78** Optics, electromagnetic theory
**80** Classical thermodynamics, heat transfer
**81** Quantum theory
**82** Statistical mechanics, structure of matter
**83** Relativity and gravitational theory
**85** Astronomy and astrophysics
**86** Geophysics
**90** Operations research, mathematical programming
**91** Game theory, economics, social and behavioral sciences
**92** Biology and other natural sciences
**93** Systems theory; control
**94** Information and communication, circuits
**97** Mathematics education

## 1.3. Protocolo

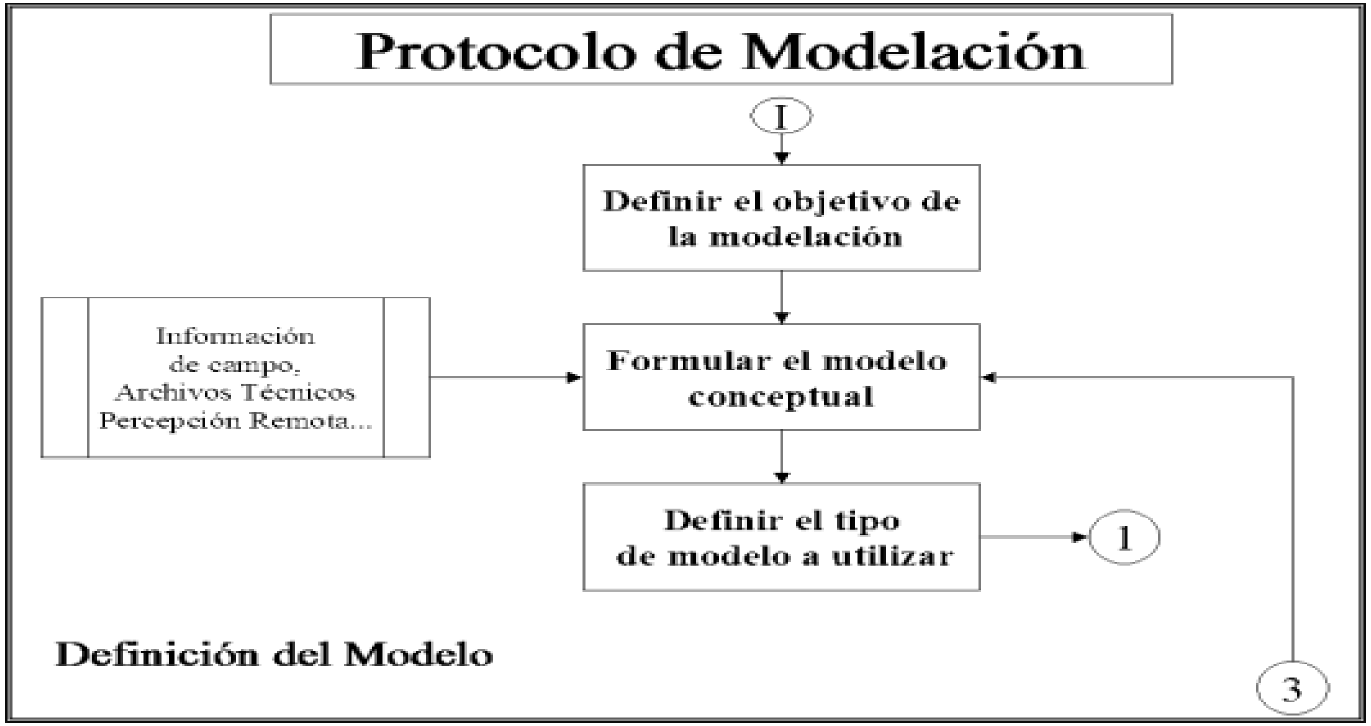


Figura3.- Primera etapa del protocolo para la modelación matemática.

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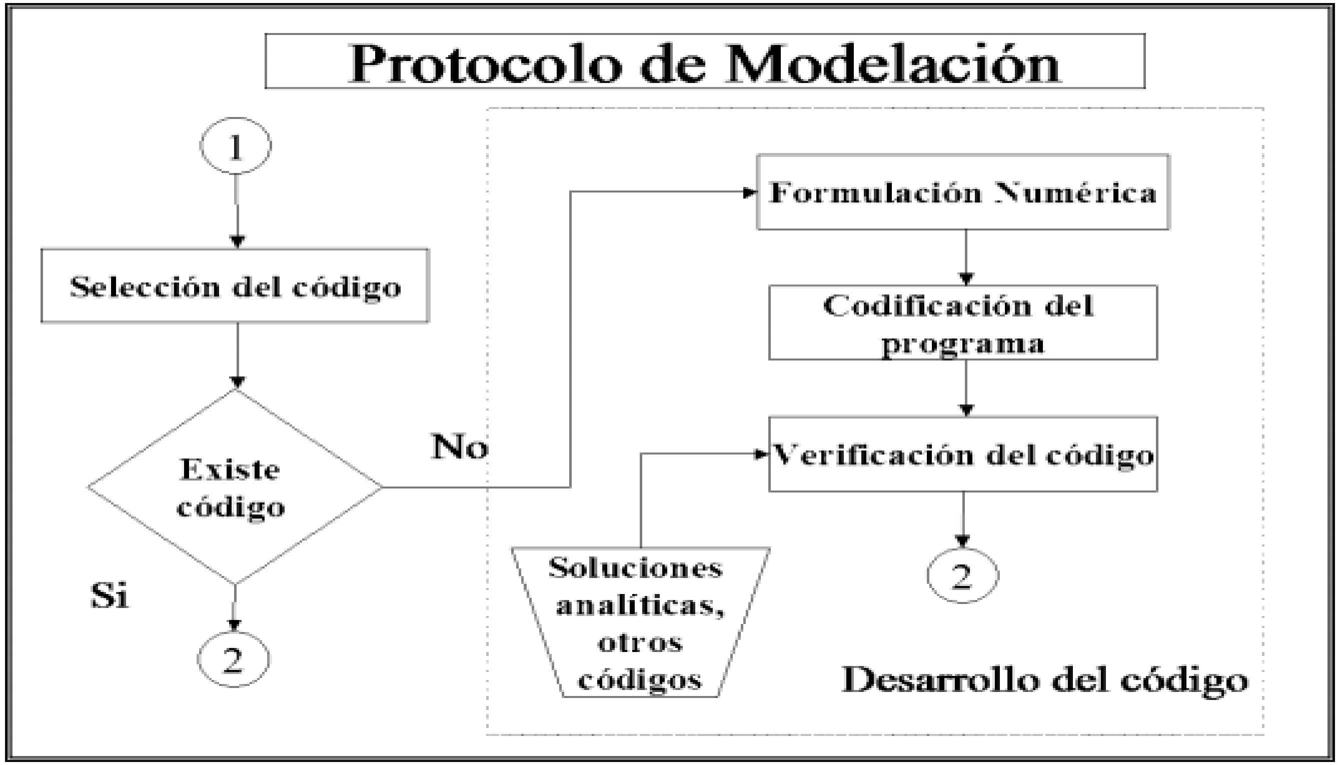


Figura4.- Segunda etapa del protocolo para la modelación matemática.

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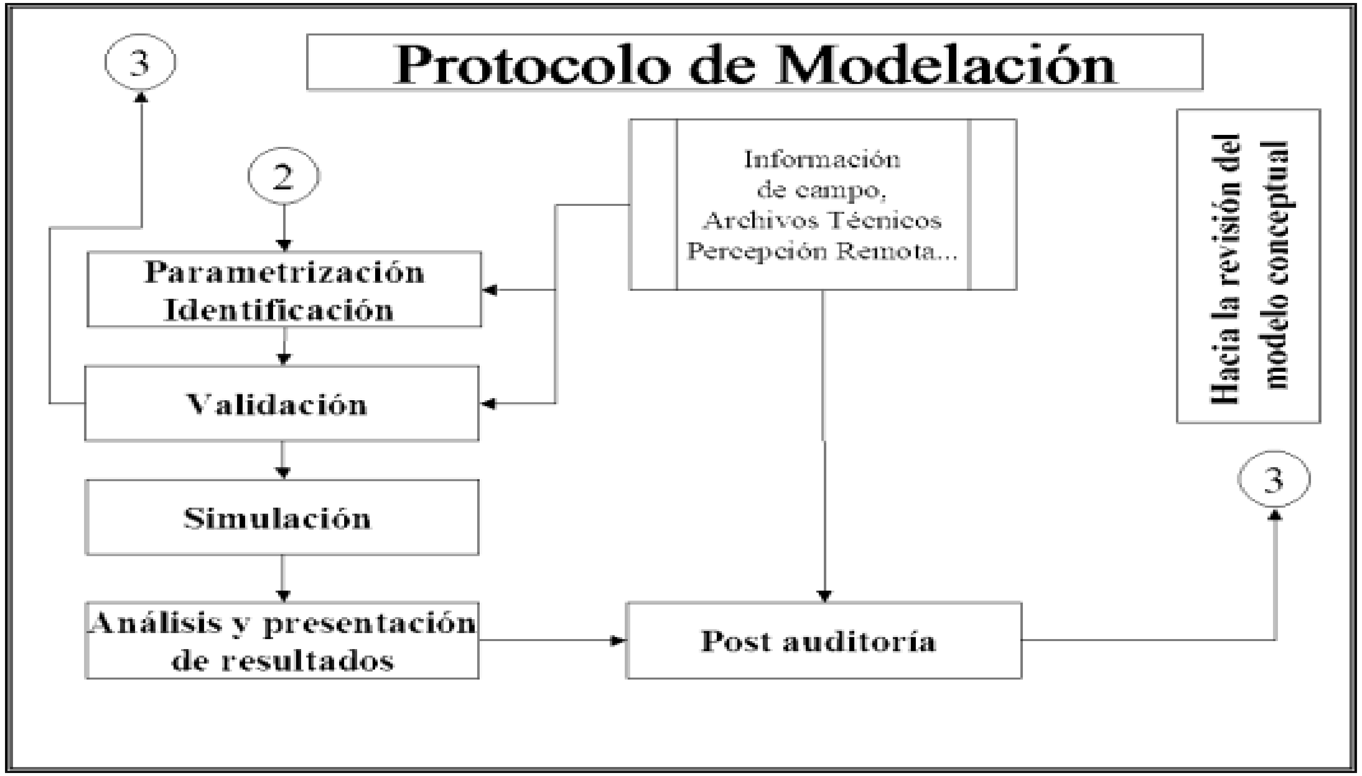


Figura5.- Tercera etapa del protocolo para la modelación matemática.

# 2. MINERÍA DE DATOS

- **2.1. Definición**

La minería de datos es el proceso de detectar la información procesable de los conjuntos grandes de datos. Utiliza el análisis matemático para deducir los patrones y tendencias que existen en los datos. Normalmente, estos patrones no se pueden detectar mediante la exploración tradicional de los datos porque las relaciones son demasiado complejas o porque hay demasiado datos (**Microsoft).**

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## 2.2. Metodología

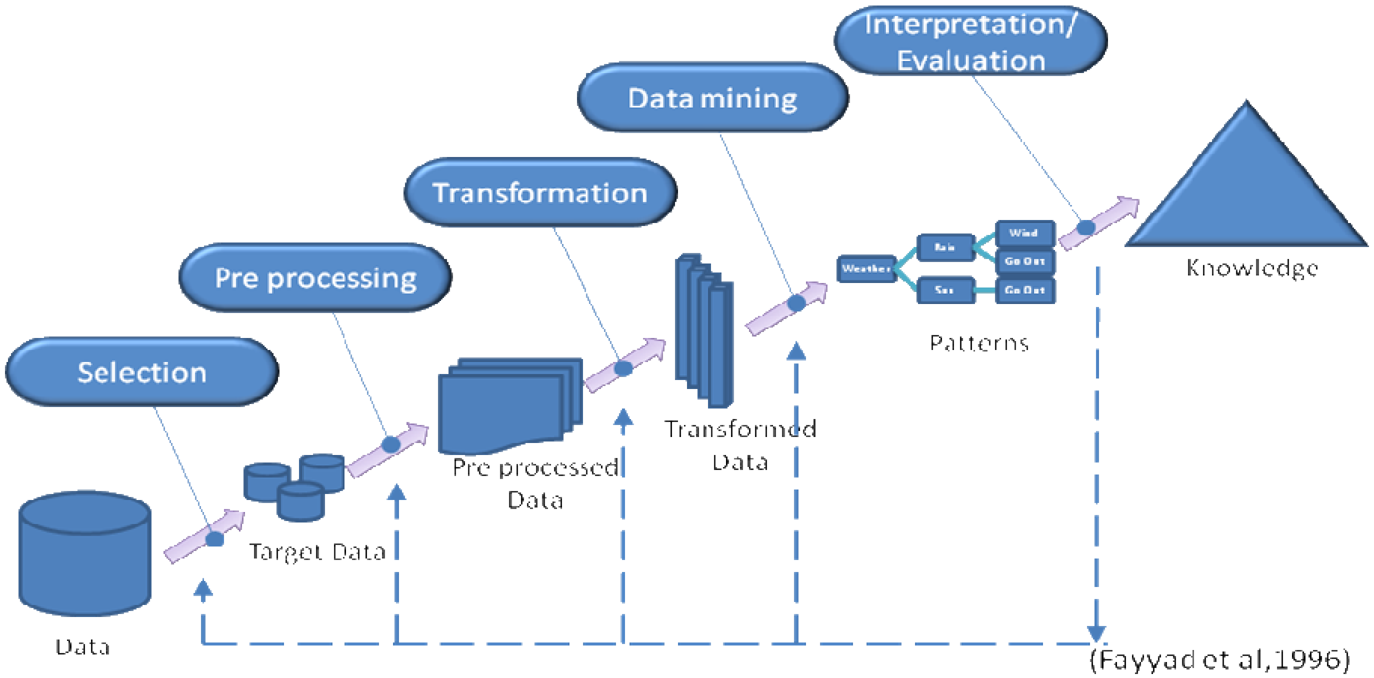


Figura 6.- Metodología KDD.

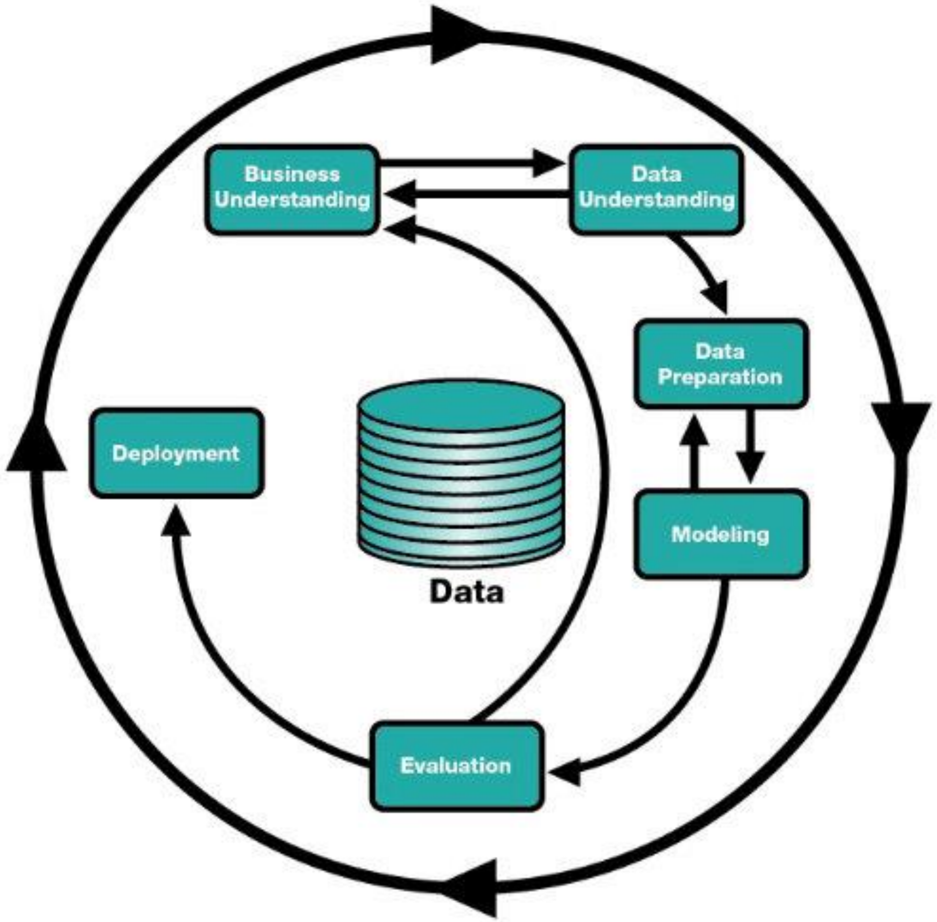


Figura 7.- Metodología CRISP-DM.

## 2.3. Algoritmos

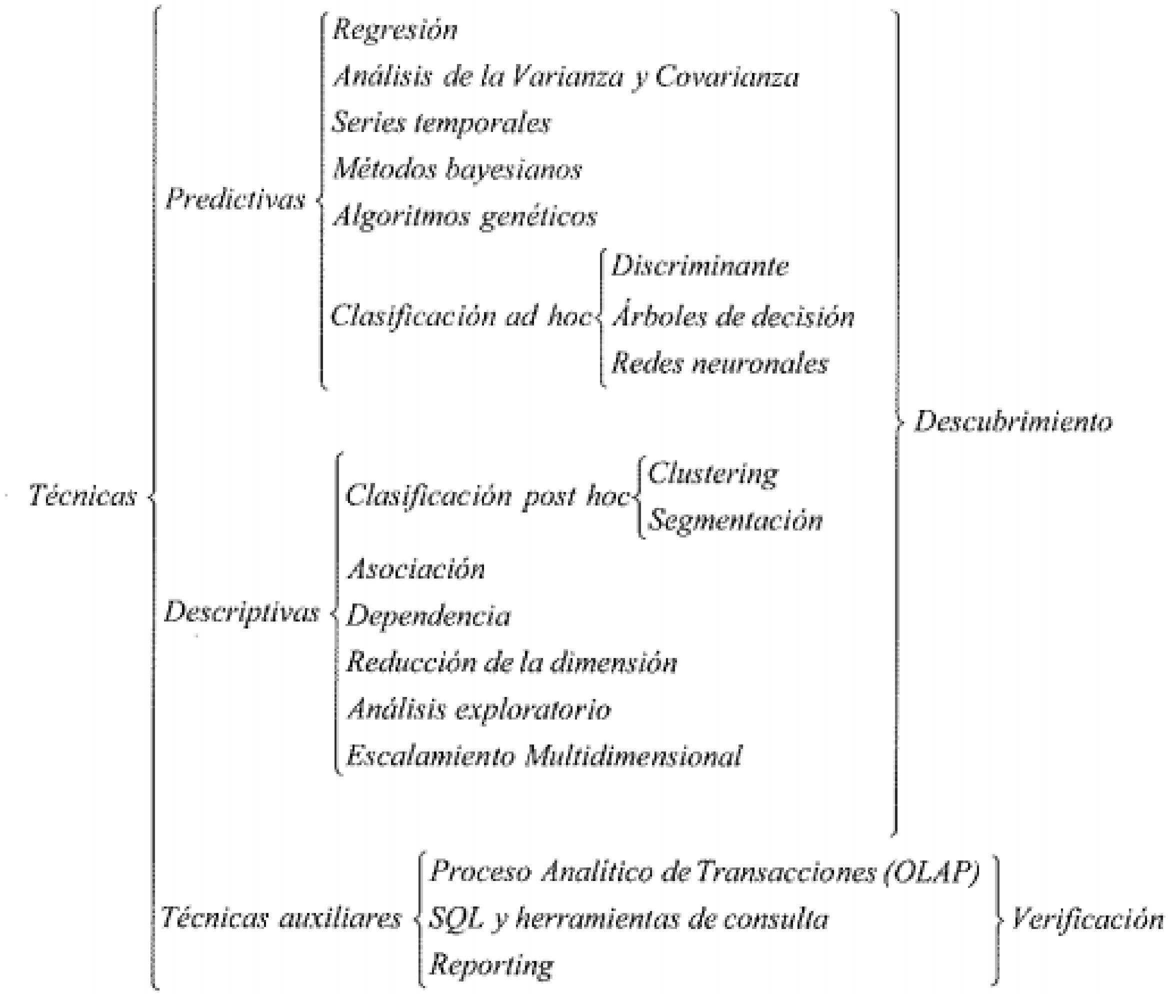


Figura 8.- Clasificación de las técnicas de Data Mining (Péres y Santín, 2008).

# 3. MODELOS DE CALIDAD DE AGUA EN RÍOS

- **3.1. Streeter Phelps**

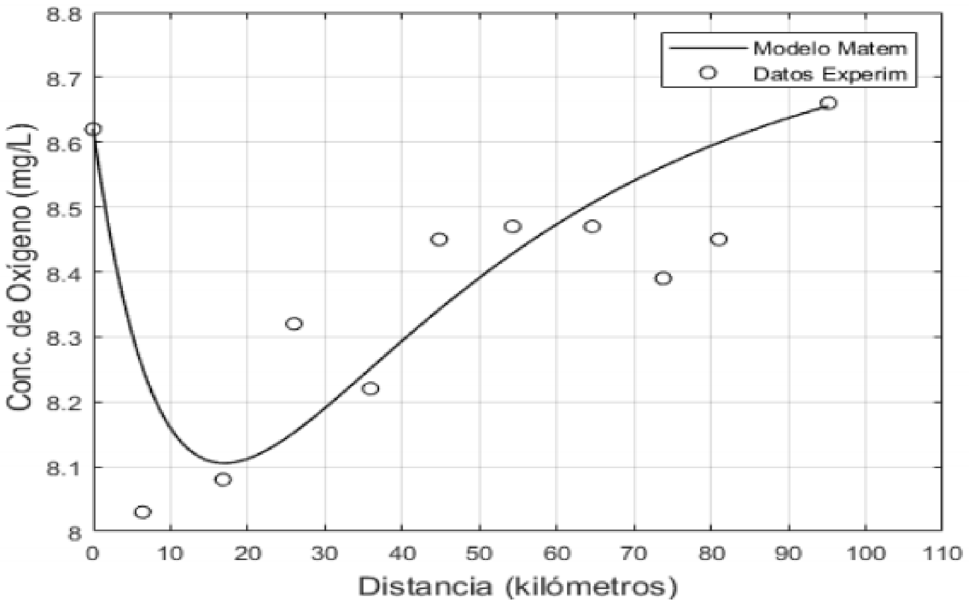


Figura 9.- Modelamiento del OD mediante Streeter-Phelps

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## 3.2. Redes Neuronales

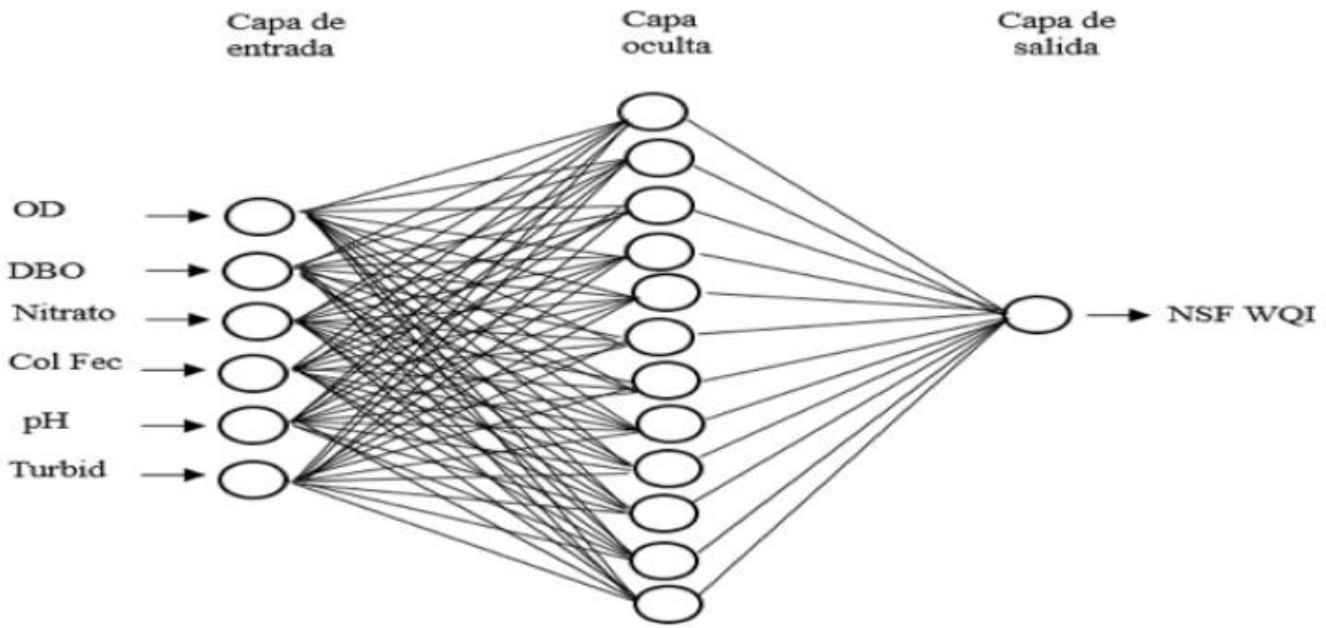


Figura 10.- Red Neuronal Artificial para estimar el índice de calidad del agua del río Utcubamba (Perú).

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## 3.3. Lógica Difusa

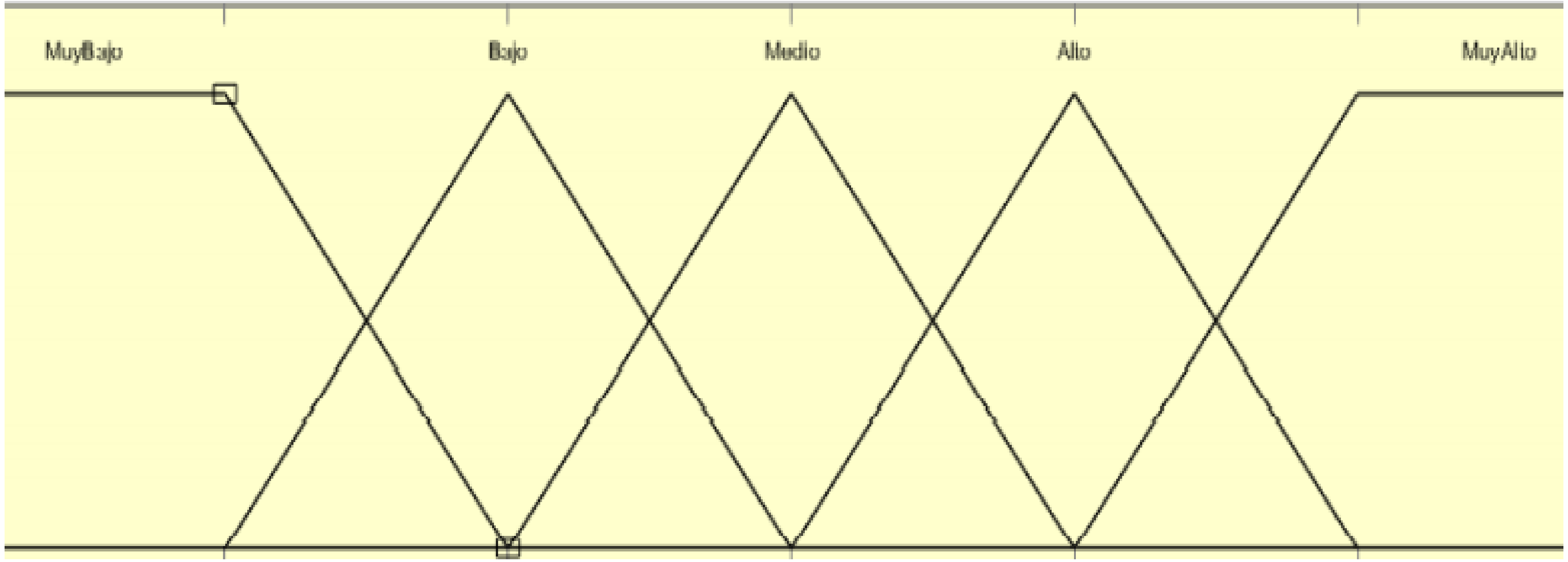


Figura 11.- Fusificación del OD.

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| Rules | Description of the fuzzy inference rule |
| --- | --- |
| Rule 1 | If Turbidity is too high or the dissolved oxygen is too low or the BOD is too high or the pH is too low or the fecal coliforms are too high or the Nitrate is too high, Then the water quality is too low. |
| Rule 2 | If turbidity is high or dissolved oxygen is low or BOD is high or pH is low or fecal coliforms are high or the nitrate is high, then the water quality is low. |
| Rule 3 | If turbidity is medium or dissolved oxygen is medium or BOD is medium or pH is medium or fecal coliforms are Medium or nitrate is Medium, then the water quality is medium. |
| Rule 4 | If turbidity is low or dissolved oxygen is high or BOD is low or pH is medium or fecal coliforms are low or the nitrate is low, then the water quality is high. |
| Rule 5 | If turbidity is very low or dissolved oxygen is very high or the BOD is very low or the pH is high or the fecal coliforms are very low or the nitrate is very low, then the water quality is very high. |
| Regla 6 | If Turbidity is high and dissolved oxygen is very low and BOD is very high and pH is very low and fecal coliforms are very high and nitrate is very high, then water quality is very low. |
| Regla 7 | If Turbidity is high and dissolved oxygen is low and BOD is high and pH is low and fecal coliforms are high and nitrate is high, then water quality is low. |
| Regla 8 | If turbidity is medium and dissolved oxygen is medium and BOD is medium and pH is medium and fecal coliforms are medium and nitrate is medium, then water quality is medium. |
| Regla 9 | If turbidity is low and dissolved oxygen is high and BOD is low and pH is medium and fecal coliforms are low and itrate is Lolw, then water quality is high. |
| Regla 10 | If turbidity is very low and dissolved oxygen is very high and BOD is very low and pH is very high and fecal coliforms are very low and nitrate is very low, then water quality is very high. |

Figura 12.- Reglas de inferencia difusa.

# *Muchas* GRACIAS

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