MACHEREY-NAGEL

P/N-Monitoring using Test Strips and the turimbi Strip Reader WebApp

Rapid Tests

Dr. Christian Prokisch, 15.07.2021

Overview

Project idea

Companies

Components

Initial results

Next steps

Summary

Project idea

Project idea

EPA Fact Sheet Nutrients

- Nitrogen and phosphorus are the primary causes of cultural eutrophication
- Approximately 25 % of all water body impairments are due to nutrient-related causes
  - Oxygen depletion
  - Algal growth
  - Ammonia
- More stringent effluent limits lead to
  - P-removal
  - N-removal

Project idea

CitizenScience.gov

- Through citizen science […] organizations can engage the American public in […] accelerating science, technology, and innovation.
- In citizen science, the public participates voluntarily in the scientific process […]

Project idea

Easy testing with test strips

- Requirements
  - Easy
  - Safe (=> no digestion)
  - Reliable results
- Conclusions
  - Use NO_3^- as indicator for total N
  - Use o-PO_4^{3-} as indicator for total P
    - New: AlgaeControl 3in1

Project idea

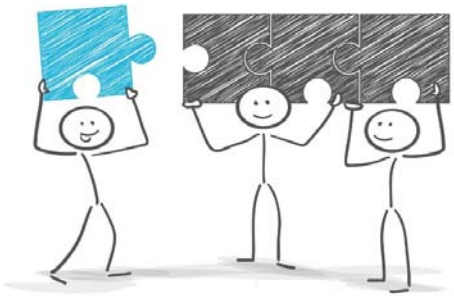
Strip evaluation by image processing

- Easy procedure
  - Take photo – upload – receive result
- Little effort
  - Use left-over mobile phone / camera
  - No installation, just https://turimbi.com
- Meaningful data
  - Create result through image upload
  - Share time / location
  - Use data, for example mapping

Project idea

Combine new and older developments

- Nitrate test pad
- New Phosphate test pad
- New Test AlgaeControl 3in1
  - Nitrate and Phosphate on one test strip
- New web-application
  - Create, share and use test results



Companies

Companies

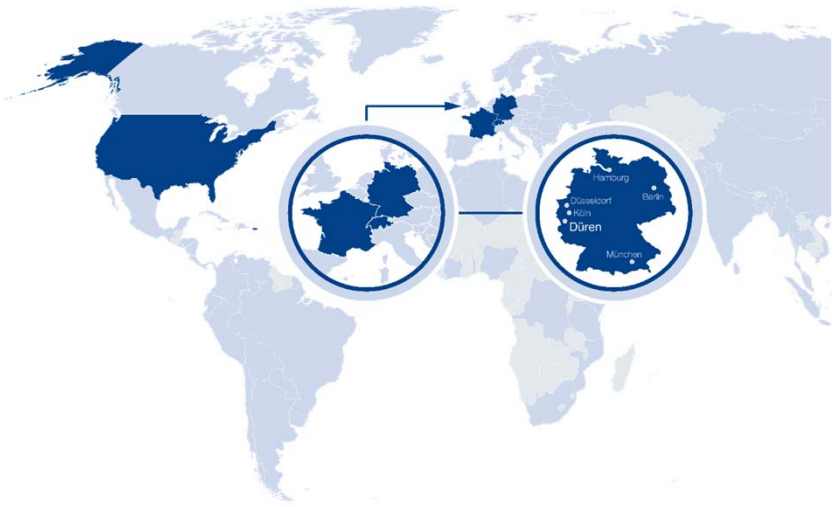
Partnership that works…

- Tetra Germany
  - Donates new AlgaeControl 3in1 Tests
- MACHEREY-NAGEL
  - Donates QUANTOFIX Nitrate 100 tests
  - Employs the author
- Turimbi
  - Connects all stakeholders
  - Develops software

Companies

MACHEREY-NAGEL

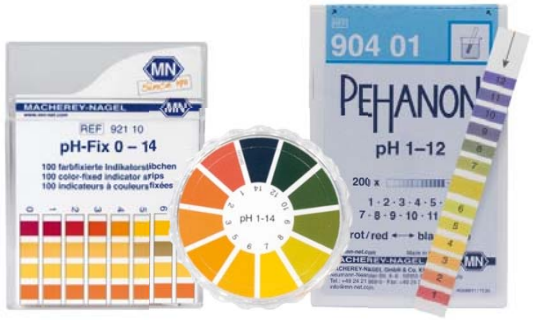
- 4th Generation family owned
- More than 700 employees
- More than 25.000 products
- Turnover 150 Mio. €



Subsidiaries Distributors

Companies

Rapid and reliable dip & read tests



Companies

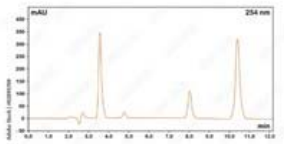
- Global market leader for the aquatics industry
  - Germany based company since 1951
  - Pioneer of contemporary fishkeeping
  - Make fishkeeping easier, safer and more user friendly
- Part of Spectrum Brands Holdings, Inc.
  - Home-essentials company
  - 2020 sales approx. $4 billion

Companies

turimbi

- Create, share and use meaningful test results
  - Test strip reader, image processing
  - Data sharing
  - Data management
- German corporation
  - More than 1 year in business
  - Turnover more than 1 EUR
  - More than 1 employee
  - ☺

Raw data



Data calculation
Data processing
Data distribution

Information

Components

Components

Tetra AlgaeControl 3in1

- Phosphate 0-0.5-2.0-5.0-10 ppm
- Nitrate 0-10-25-50-100 ppm
- Procedure
  - Dip in sample for 2 s
  - Wait 120 s (original 60)
  - Blot strip to remove excess liquid
  - Take photo and upload

Components

QUANTOFIX® Nitrate 100 when higher sensitivity is necessary

- No Phosphate test included
- Nitrate 0-**5**-10-25-50-75-100 ppm
- Procedure
  - Dip in sample for 1 s
  - Shake off excess liquid
  - Wait 120 s (original 60)
  - Place on self printed background
  - Take photo

Components

WebApp

- Create
  - Select “MyMethod”
  - Upload image
- Share
  - Invite others to share your method
  - Group members see all data of the group
- Use
  - Download group data (csv)
  - Process data for example with Excel

turimbi

create

share

use

Initial results

Initial results

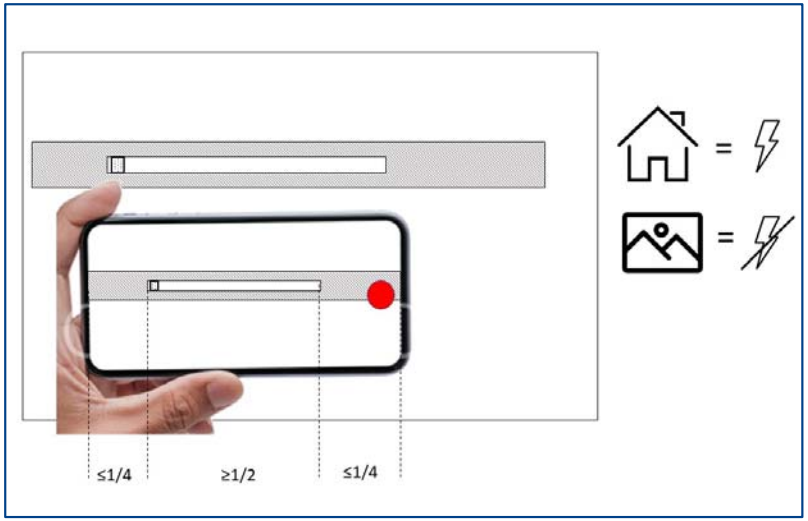
„Lab“ performcance tests with standards

- Color temperature 3200-4000-4800-5600 K (photo LED panel)
- Intensity 100-70-40-10 % a.u. (photo LED panel)
- Standard concentrations
  - Nitrate: 0-10-25-50-100 ppm
  - Phosphate 0-0.5-2.0-5.0-10.0 ppm
- Result with Tetra AlgaeControl 3in1
  - Nitrate 93 % on spot
  - Phosphate 90 % on spot

Initial results

Different „real“ conditions

- 7 different smartphones
- Different backgrounds
  - Grey
  - White paper with darker box
- Image requirements
  - Non distorted
  - White balanced



Instruction for use

Initial results show correct readings

Initial results

Outdoor experience

- Sampling
  - Clipstick
  - Quickdraw
  - Cup
- Samples
  - Standards
  - Surface water
- Test strips
  - pH-Fix 0-14
  - Tetra AlgaeControl 3in1

Initial results

Results

- Strip reading
  - Works well in outdoor practice
  - Good workflow
  - Overexposure may lead to image rejection
- Results
  - Standard recovery 100%
- Sampling
  - Home-brew sampler works
- River Rur (near Düren)
  - Very clean
  - NO_3^- / PO_4^{3-} concentration too low for mapping

Initial results

Best practice

- Choose (outdated) smartphone from premium brand (iPhone 6S…)
- Use holder
- Reduce image size to 0.5-1 MB
  - 3G response time: 2-3 seconds
- No signal? Upload at home!
  - Time / location in the image

Convenient, full featured, mobile strip reader

Next steps

Next steps

Possible nitrate / phosphate projects

- Surface water screening
  - Nutrient screening
  - Engage public
  - Create (more) public awareness for nutrient removal
- Ground water screening
  - Nitrate gets into drinking water
  - Create (more) farmer awareness for responsible use of fertilizers

Next steps

Examples for other possible test strips

- Free Chlorine (0,05 – 1 ppm)
  - Easy drinking water testing in non-regulated applications
- Disinfectants
  - Potency check
  - Residual check
- pH
- Lateral flow tests (pregnancy type test strips)

Next steps

Turimbi developments (funds / time provided)

- Add new modules
  - Users “Initial demonstration of capability”
  - Verification options
  - Control charts
- Improve
  - Design
  - User interface
  - Group management (add managed group)
  - When necessary: scale-up

Summary

Summary

P/N-Monitoring using test strips and turimbi strip reader

- Image processing provides good results
- Website helps to engage users
- Cheap
- Recycle old mobile phones into strip readers
- Data may provide good local insights
- Would like to see it in use in a CS project

Summary

Special thanks

- MACHEREY-NAGEL for allowing me to give this presentation
- Tetra for supporting the idea
- All the nerds and corporations that donate their work to build and keep
  - Python including Numpy Scipy
  - MySQL
  - Docker

MACHEREY-NAGEL

Interested in a citizen science project?

Dr. Christian Prokisch, cprokisch@mn-net.com, +49-2421-969166

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